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GEOSAT Follow-On (GFO) Altimeter Document Series

Volume 7

GFO Altimeter Engineering Assessment Report

Update:
The First 87 Cycles Since Acceptance
November 29, 2000 to December 17, 2004

Version 1

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Foreword

The Navy's Geosat Follow-On (GFO) Mission, launched on February 10, 1998, is an altimetric satellite with heritage that includes Seasat, Geosat, TOPEX/POSEIDON (T/P), and ERS-1. Data derived from these missions has and will lead to improvements in the knowledge of ocean circulation, ice sheet topography, and climate change. In order to capture the maximum amount of information from the altimetric data, accurate altimeter calibrations are required for the GFO civilian data set that NOAA produces. NASA/Goddard Space Flight Center/Wallops Flight Facility (GSFC/WFF) has provided these calibrations for the Seasat, Geosat and T/P missions, and is doing the same for GFO.

Wallops' multiple roles with regard to GFO are:

- NASA Representative for Radar Altimeter Performance
- Calibration Collaboration
- Member of GFO Cal-Val Team
- Data distribution to members of Cal-Val Team
- Validate sensor-related corrections
- Provide corrections for sensor changes

For the latest updates on the performance of the GFO Radar Altimeter, and for accessing many of our reports, readers are encouraged to contact our WFF/GFO Home Page at http://gfo.wff.nasa.gov/

This WFF GEOSAT Follow-On (GFO) Altimeter Engineering Assessment Report has been prepared by SGT, Inc./GGSG under Contract NAS5-00181 with the NASA Goddard Space Flight Center, Greenbelt, Maryland. This work was performed under the direction of David W. Hancock, III, WFF GFO Altimeter Verification Manager, Cryospheric Sciences Branch, Hydrospheric and Biospheric Sciences Laboratory, NASA Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Virginia. Mr. Hancock may be contacted at (757) 824-1238 (voice), David.W.Hancock @nasa.gov (e-mail), or (757) 824-1036 (fax).

Acknowledgments

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Section 1

Introduction

1.1 Identification of Document

The purpose of this document is to present and document GFO performance analyses and results. It is the fifth of a series of GFO performance documents, each of which updates WFF's assessment results. This is the fourth Assessment Report since the initial report. This report extends the performance assessment since acceptance to 17 December 2004.

The initial GFO Altimeter Engineering Assessment Report, in March 2001, covered the GFO performance from Launch to Acceptance (10 February 1998 to 29 November 2000). The second of the series covered the performance from Acceptance to the end of Cycle 20 (29 November 2000 to 21 November 2001). The third of the series covered the performance from Acceptance to the end of Cycle 42 (29 November 2000 to 30 November 2002). The fourth of the series covered the performance from Acceptance to the end of Cycle 64 (29 November 2000 to 17 December 2003).

Since launch, we have performed a variety of GFO performance studies; Appendix A provides an accumulative index of those studies.

1.2 Definition of a GFO Cycle

Like its predecessor, GEOSAT, the GFO groundtrack has a repeat ($\pm$1 km) period of 17.05 days. For our analyses, the repeat periods are referred to as cycles, and are used as data dividers to assess sensor internal consistency, taking into account seasonal differences.

For simplification in tracking the performance of the satellite, the Navy is using exactly 17-day boundaries in the definition of a cycle. The first 17-day cycle after acceptance by the Navy is numbered 000, Cycle 000, and is used as a reference for the succeeding cycles. The 17-day cycle which started on December 16, 2000 (Julian day 2000352) is the beginning of the first evaluation cycle, Cycle 001, which ended on January 2, 2001 (Julian day 2001002). Each subsequent cycle is consecutively numbered.

1.3 Data Flow to/from Wallops

1.3.1 To Wallops

The daily near-real time GFO data flow from the Naval Oceanographic Office (NAVO), Altimetry Data Fusion Center (ADFC), Stennis Space Center, Bay St. Louis, MS, to Wallops Flight Facility (WFF) consists of:

- Science data without waveforms (ra_data)
- Science data with waveforms (ra_cal_data)
- Engineering data (eng_data)

- Water Vapor Radiometer data (wvr_data)
- Sensor data (sdr)

Additional data are forwarded by the Navy to Wallops as soon as it is available, consisting of:

- Navy Geophysical Data (ngdr)
- Operational Orbital Determination data (oodd)

1.3.2 From Wallops to Cal/Val Team Members

Wallops forwards the following GFO data types to the other members of the Cal/Val Team:

- Sensor data (sdr)
- Science data with waveforms (ra_cal_data)
- Operational Orbital Determination data (oodd)

Section 2

On-Orbit Instrument Performance (Cycles 00 through 86)

From the time of acceptance on November 29, 2000, to the end of this reporting period, the GFO altimeter has acquired a total of 87 cycles of data. Cycles 59 through 61 were not processed due to a CPU reset that placed the altimeter into a safe-hold; the time period of the safe-hold was from 9 September 2003 (2003-249) to 20 October 2003 (2003-293). Cycles 70 and 71 were not processed due to payloads being powered off as a preventative measure and for additional satellite maintenance; the time period of the payload power off was from 22 February 2004 (2004-053) to 09 April 2004 (2004-100). Since its Acceptance, the GFO altimeter has acquired a total of 1366 days of data.

The following subsections will illustrate that the altimeter tracking data have been internally consistent. The subsections discuss:

- internal calibrations
- cycle summaries
- key events

2.1 Internal Calibrations

The GFO's internal calibration mode has two submodes, designated CAL-1 and CAL-2. CAL-1 is designed to detect changes in the internal path delays, to measure range drift. CAL-1 also monitors changes in the receiver automatic change control (AGC); the altimeter's estimates of the ocean surface radar backscattering cross-section are obtained from the AGC values. The purpose of the second mode, CAL-2, is to characterize the response of the receiver and digital filter bank.

During CAL-1, a portion of the transmitter output is fed back to the receiver through a digitally controlled calibration attenuator and a delay line, whereupon the altimeter acquires and tracks the signal. Then, during CAL-2, the altimeter processes received thermal noise with no transmitted signal present, to characterize the waveform sampler response.

The GFO Project normally provides two internal calibrations per day.

Prior to Wallops' receiving the calibration data, the GFO ground data processing system routinely performs the following: (1) adds a large constant bias to the CAL-1 range, such that the magnitude of the resultant range sum is comparable to a nominal nadir altimeter range to the surface of the earth, and then (2) applies an oscillator drift correction to the total range.

To reconstruct a meaningful CAL-1 range, Wallops performs the following: (1) using the GFO-Project-provided VTCW (Vehicle Time Code Word), removes the oscillator drift correction, and then (2) removes a large constant bias.

2.1.1 Range

The CAL-1 range calibrations are shown in the middle of Figure 2-1 "CAL-1 Range/ Temperatures for the First 87 Cycles", denoted by the pluses and are referenced to the left vertical scale in millimeters. The data plotted nearer the bottom of the figure, denoted by the diamonds, are the Composite Temperature corresponding to the times of the calibrations; the temperatures are referenced to the right vertical scale in degrees centigrade. A small, and linearly decreasing, temperature dependence is noted in the CAL-1 range. At the time of Acceptance near the end of year 2000, the CAL-1 range dependence on Receiver Temperature, as observed in Figure 2-1, was approximately +0.8 mm per degree. Since that time, the temperature dependence has been decreasing at the rate of -0.2 mm per degree per year. At the end of 2003, the dependence is only approximately +0.2 mm per degree. The total span of the CAL-1 range temperature dependencies has remained within the centimeter range specification for GFO.

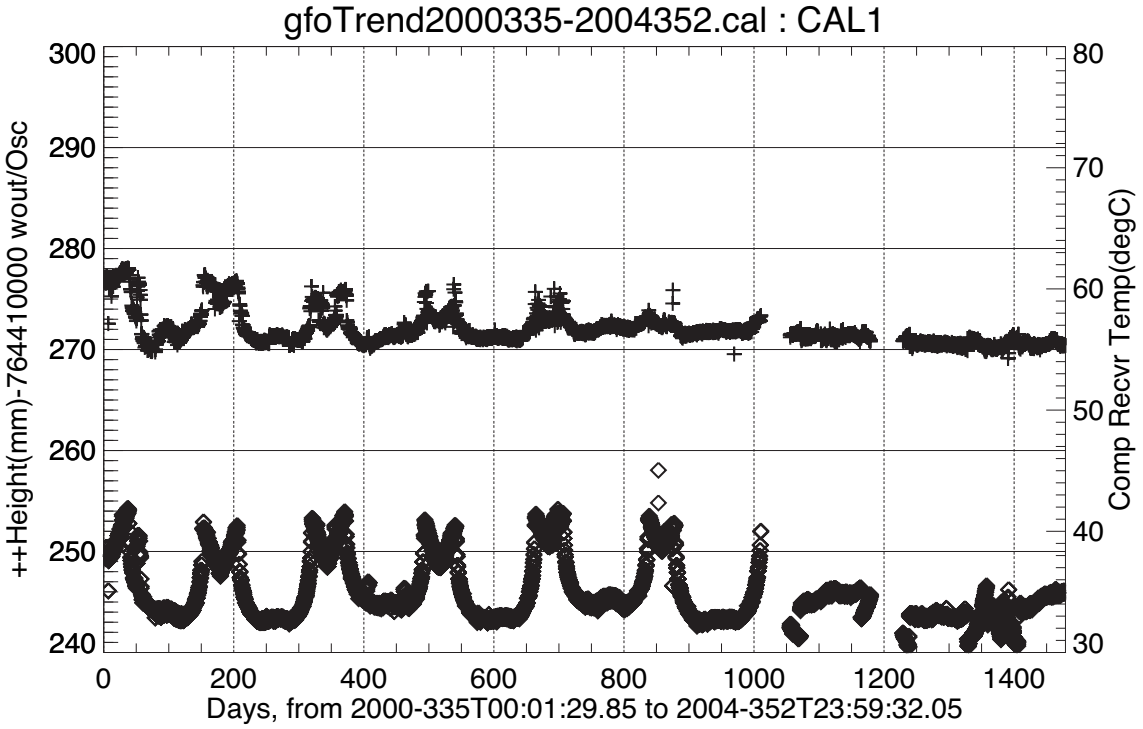

Figure 2-1 CAL-1 Range/Temperatures for the First 87 Cycles

2.1.2 AGC

The CAL-1 and CAL-2 AGCs have been routinely temperature-corrected using an algorithm derived by Wallops. The same AGC temperature correction algorithm is used for both CAL-1 and CAL-2, although the correction algorithm is based solely on the CAL-1 data.

During the first 65 cycles, after temperature correction, the CAL-1 AGCs remain in a fairly narrow band of 42.6$\pm$0.1 dB, as shown in Figure 2-2 "CAL-1 AGC for the First 87 Cycles". No significant AGC drift is noted, and no further temperature dependency is indicated.

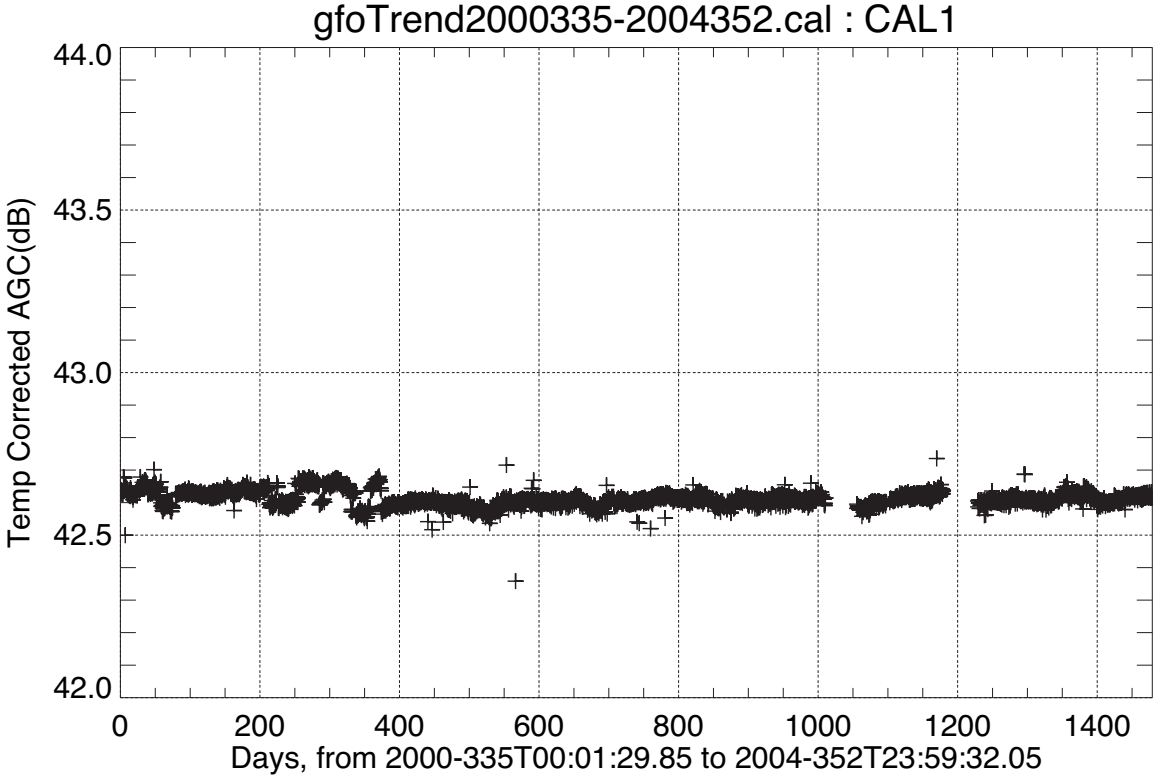

Figure 2-2 CAL-1 AGC for the First 87 Cycles

After applying the temperature correction, a CAL-2 AGC residual temperature dependence is evident in Figure 2-3 "CAL-2 AGC for the First 87 Cycles". The CAL-2 residuals are observed to be correlated with and correctable with temperature as can be seen by the temperature plot depicted by the diamonds at the bottom of Figure 2-1. For the temperature correction algorithm, WFF elected to apply the temperature correction for CAL-1 and not CAL-2 as being more applicable for normal operational AGC processing.

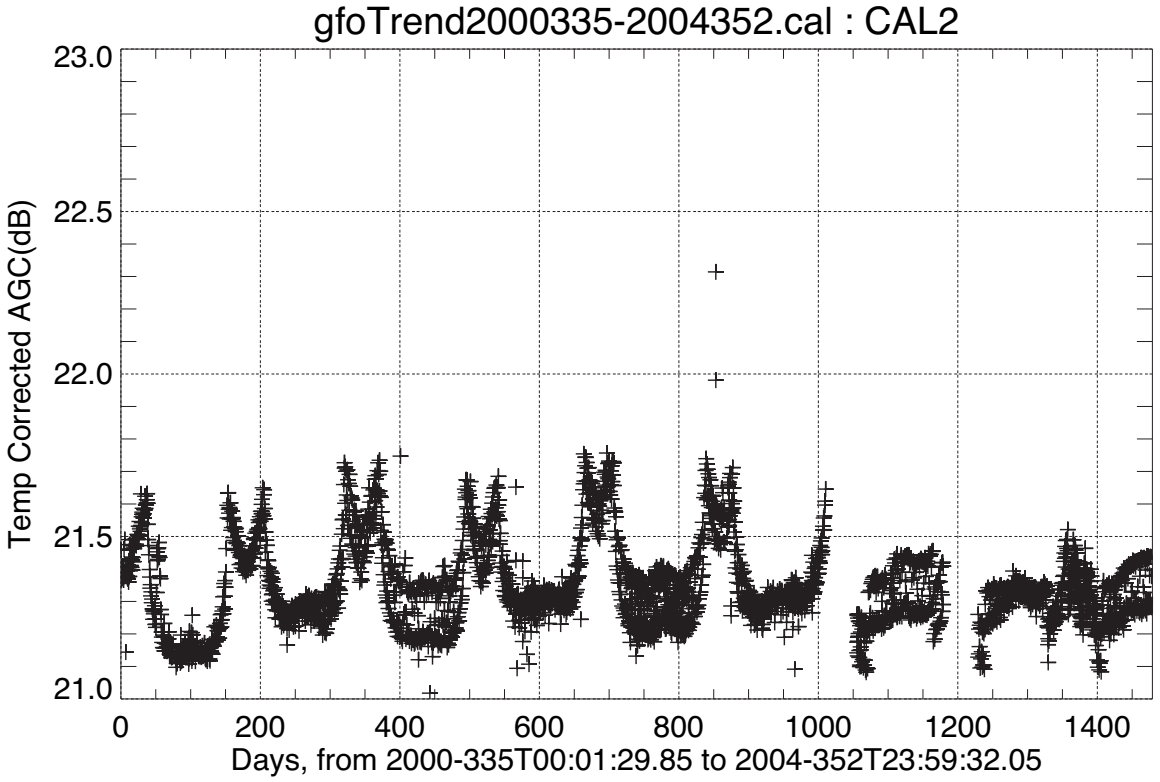

Figure 2-3 CAL-2 AGC for the First 87 Cycles

2.2 GFO Cycle (17-day) Summaries

Another indication of the GFO altimeter's internal consistency is the agreement of cycle-to-cycle means for: global significant waveheights, sigma-naughts, and wind-speed. For this analysis, the measurements for complete cycles (17 days) were meaned, standard deviations were computed, and measurement histograms were produced.

Prior to the computations, the data sets were edited to eliminate suspect measurements. Our edit criteria are as follows:

- Quality Word #1
  - Bit 2: Record is zero-filled
  - Bit 3: Altimeter not in Fine Track

  - Bit 5: Receiver Temperature error
  - Bit 7: No smoothed VATT
  - Bit 10: SWH bounds error
  - Bit 18: Off-Nadir error
  - Bit 19: SWH standard error
  - Bits 22-31: More than 5 frames missing
- Quality Word #2
  - Bit 11: Land contamination
- Default fill values indicative of bad data

Note: Bit 0 is defined as LSB

We suggest the use of above criteria by data users for editing the GFO data.

The process by which the cycle summaries were produced involved the following criteria:

- 60 second averaging interval
- $0.2 < SWH < 12.0$
- $-66.0 < Latitude < 66.0$
- $6.0 < Sigma0 < 16.0$
- $44 <$ Numpoints in intervals < 62

All the cycle summaries produced at Wallops so far indicate excellent cycle-to-cycle consistency. Summaries for the first 87 cycles (cycles numbered 0-86) are shown in Table 2-1 "GFO Cycle Summaries".

Column Definitions for Table 2-1 Cycle Summaries	
Cycle	Equivalent to Exactly 17 Days
Days in Cycles	Beginning Year and Julian Day through the Ending Year and Julian Day of the Cycle
SSHUSTD (m)	Cycle Average Uncorrected Sea Surface Height Standard Deviation
SWH (m)	Cycle Average Significant Wave Height
Sigma0 (dB)	Cycle Average Sigma0
AGC (dB)	Cycle Average Automatic Gain Control
Attitude (deg)	Cycle Average Attitude
RecvrTemp (C)	Cycle Average Receiver Temperature
WindSpeed (.1m/s)	Cycle Average Windspeed
# Points Used	Total Number of Points Processed in the Cycle Period used in the Cycle Average

Table 2-1 GFO Cycle Summaries

Cycle	Days in Cycle, yyddd	SSHUSTD, m	SWH, m	Sigma0, dB	AGC, dB	Attitude, deg	RecvrTemp, C	WindSpeed, 0.1m/s	# Points Used
0	00335 - 00351	0.0426	2.4634	11.3467	43.2169	0.2392	38.1004	82.2133	661930.0
1	00352 - 01002	0.0435	2.5893	11.5076	43.3676	0.2502	39.7169	76.9435	670179.0
2	01003 - 01019	0.0421	2.4539	11.5464	43.4072	0.2422	38.1625	76.1032	705661.0
3	01020 - 01036	0.0424	2.5145	11.3383	43.2053	0.2105	35.9461	82.4006	705066.0
4	01037 - 01053	0.0428	2.5048	11.2909	43.1539	0.2340	33.6365	83.9581	575112.0
5	01054 - 01070	0.0440	2.5950	11.3143	43.1754	0.2362	33.5342	83.6164	792452.0
6	01071 - 01087	0.0443	2.6296	11.3496	43.2111	0.2335	33.3062	82.7288	778777.0
7	01088 - 01104	0.0448	2.6688	11.2597	43.1205	0.2255	33.2810	85.4292	727955.0
8	01105 - 01121	0.0442	2.6110	11.3374	43.1974	0.2270	35.3536	82.6415	781960.0
9	01122 - 01138	0.0445	2.5979	11.5202	43.3821	0.2361	38.7920	77.0297	682787.0
10	01139 - 01155	0.0429	2.4273	11.5259	43.3883	0.2254	37.1360	77.1754	769511.0
11	01156 - 01172	0.0431	2.4743	11.5309	43.3925	0.2301	38.9564	77.0553	761652.0
12	01173 - 01189	0.0442	2.6248	11.3143	43.1751	0.2200	36.1441	83.6154	767214.0
13	01190 - 01206	0.0437	2.5423	11.3137	43.1745	0.2083	33.2537	81.3067	750630.0
14	01207 - 01223	0.0441	2.6452	11.1944	43.0576	0.2097	32.7243	87.3751	747226.0
15	01224 - 01240	0.0428	2.5422	11.2748	43.1381	0.2180	32.9023	84.7361	757575.0
16	01241 - 01257	0.0440	2.5988	11.2864	43.1472	0.2232	32.8176	84.7772	752352.0
17	01258 - 01274	0.0441	2.5846	11.3227	43.1835	0.2298	33.1715	83.4550	708963.0
18	01275 - 01291	0.0442	2.6115	11.4142	43.2758	0.2441	36.5931	80.1253	733146.0
19	01292 - 01308	0.0422	2.3769	11.5406	43.4015	0.2506	39.0869	76.0492	740202.0
20	01309 - 01325	0.0431	2.4908	11.3894	43.2502	0.2456	38.0352	80.7366	763436.0
21	01326 - 01342	0.0423	2.4054	11.5086	43.3702	0.2565	40.3354	76.7640	760609.0
22	01343 - 01359	0.0421	2.4211	11.3740	43.2340	0.2390	36.0733	81.4164	776570.0
23	01360 - 02011	0.0430	2.4595	11.3632	43.2214	0.2372	34.6067	81.6712	777658.0
24	02012 - 02028	0.0419	2.4555	11.2929	43.1544	0.2374	33.8748	83.8318	788337.0
25	02029 - 02045	0.0434	2.5995	11.2344	43.0959	0.2403	33.9140	85.6793	793967.0
26	02046 - 02062	0.0418	2.4363	11.3118	43.1726	0.1960	33.7699	83.3240	776874.0
27	02063 - 02079	0.0420	2.4820	11.2993	43.1601	0.0959	34.0986	83.7140	759495.0
28	02080 - 02096	0.0431	2.5973	11.3047	43.1647	0.1062	35.5185	83.6089	763915.0
29	02097 - 02113	0.0429	2.5122	11.4835	43.3435	0.1303	39.3145	78.3730	777198.0
30	02114 - 02130	0.0433	2.5705	11.3721	43.2352	0.1275	37.5810	81.2207	771475.0
31	02131 - 02147	0.0431	2.5229	11.5137	43.3769	0.1378	39.4172	77.3539	769096.0
32	02148 - 02164	0.0426	2.4842	11.3335	43.1951	0.1176	34.9234	82.7158	751307.0
33	02165 - 02181	0.0432	2.5975	11.1661	43.0261	0.0936	33.2024	88.1230	695887.0

Table 2-1 GFO Cycle Summaries (Continued)

Cycle	Days in Cycle, yyddd	SSHUSTD, m	SWH, m	Sigma0, dB	AGC, dB	Attitude, deg	RecvrTemp, C	WindSpeed, 0.1m/s	# Points Used
34	02182 - 02198	0.0426	2.4700	11.2788	43.1397	0.0891	32.8489	84.6981	759199.0
35	02199 - 02215	0.0436	2.6013	11.2309	43.0918	0.0856	32.9862	86.5075	753679.0
36	02216 - 02232	0.0437	2.5655	11.2559	43.1159	0.0816	32.9686	85.8057	756166.0
37	02233 - 02249	0.0432	2.4940	11.3231	43.1839	0.0824	33.1290	83.5694	750831.0
38	02250 - 02266	0.0433	2.4764	11.4104	43.2782	0.0984	35.2167	80.6096	722417.0
39	02267 - 02283	0.0417	2.3496	11.5440	43.4040	0.1257	39.8588	75.9570	790561.0
40	02284 - 02300	0.0429	2.4216	11.5900	43.4525	0.1260	39.4430	74.9548	741718.0
41	02301 - 02317	0.0452	2.4552	11.4899	43.3531	0.1291	39.5481	77.9058	758725.0
42	02318 - 02334	0.0366	2.4707	11.3157	43.1773	0.1060	34.9509	83.2591	726926.0
43	02335 - 02351	0.0454	2.5430	11.3260	43.1868	0.0985	33.9964	83.1453	777845.0
44	02352 - 03003	0.0366	2.4304	11.3788	43.2456	0.0919	33.9796	81.3639	756223.0
45	03004 - 03020	0.0370	2.5188	11.3788	43.2722	0.0954	34.3442	81.5900	759120.0
46	03021 - 03037	0.0437	2.4140	11.3696	43.2318	0.0969	34.1612	81.2326	796658.0
47	03038 - 03054	0.0445	2.5299	11.3311	43.1919	0.0954	33.9011	82.8948	803538.0
48	03055 - 03071	0.0448	2.4707	11.4510	43.3133	0.1025	35.1232	79.4225	797328.0
49	03072 - 03088	0.0449	2.5453	11.5661	43.4293	0.1270	39.8270	76.2134	789422.0
50	03089 - 03105	0.0455	2.5855	11.4690	43.3298	0.1281	39.2894	78.8082	781713.0
51	03106 - 03122	0.0449	2.5349	11.4994	43.3594	0.1312	38.9355	77.9592	721614.0
52	03123 - 03139	0.0456	2.5981	11.2533	43.1156	0.1118	34.3041	85.6061	788121.0
53	03140 - 03156	0.0455	2.5929	11.3193	43.1808	0.1047	32.9220	83.7258	775966.0
54	03157 - 03173	0.0447	2.4875	11.3113	43.1713	0.0990	32.7629	84.0875	771445.0
55	03174 - 03190	0.0444	2.3957	11.3784	43.2419	0.0921	32.9165	82.0420	746389.0
56	03191 - 03207	0.0452	2.6326	11.1701	43.0333	0.0867	32.8827	88.5271	767126.0
57	03208 - 03224	0.0454	2.5396	11.3199	43.1814	0.0816	32.9097	84.0493	762023.0
58	03225 - 03241	0.0439	2.3609	11.4089	43.2740	0.0870	34.1636	81.0249	751092.0
59	03242 - 03258								
60	03259 - 03275								
61	03276 - 03292								
62	03293 - 03309	0.0445	2.3825	11.3561	43.2171	0.0753	31.5633	82.6144	714232.0
63	03310 - 03326	0.0452	2.4420	11.3125	43.1733	0.0952	33.8310	83.4008	766574.0
64	03327 - 03343	0.0444	2.4505	11.3686	43.2403	0.0958	34.0098	81.8461	598223.0
65	**03344 - 03360**	**0.0442**	**2.4414**	**11.3529**	**43.2171**	**0.0971**	**34.7116**	**81.7847**	**727762**
66	**03361 - 04012**	**0.0431**	**2.3448**	**11.3925**	**43.254**	**0.0982**	**34.6763**	**80.6005**	**797884**
67	**04013 - 04029**	**0.0438**	**2.399**	**11.4714**	**43.3338**	**0.1055**	**34.5151**	**78.636**	**787084**
68	**04030 - 04046**	**0.0438**	**2.4265**	**11.3416**	**43.2058**	**0.0958**	**33.9595**	**82.3677**	**783256**

Table 2-1 GFO Cycle Summaries (Continued)

Cycle	Days in Cycle, yyddd	SSHUSTD, m	SWH, m	Sigma0, dB	AGC, dB	Attitude, deg	RecvrTemp, C	WindSpeed, 0.1m/s	# Points Used
69	**04047 - 04063**	**0.0449**	**2.5274**	**11.3894**	**43.2494**	**0.0927**	**34.0635**	**81.0399**	**320568**
70	**04064 - 04080**								
71	**04081 - 04097**								
72	**04098 - 04114**	**0.0459**	**2.6563**	**11.2089**	**43.0708**	**0.0893**	**31.5338**	**87.3962**	**651944**
73	**04115 - 04131**	**0.0453**	**2.6239**	**11.2271**	**43.0887**	**0.1005**	**33.022**	**86.1777**	**793578**
74	**04132 - 04148**	**0.0443**	**2.4494**	**11.388**	**43.248**	**0.0977**	**33.1254**	**81.6354**	**778311**
75	**04149 - 04165**	**0.0458**	**2.5434**	**11.2702**	**43.131**	**0.0994**	**33.3311**	**84.9079**	**779784**
76	**04166 - 04182**	**0.0451**	**2.5768**	**11.223**	**43.0863**	**0.0944**	**33.1352**	**86.8351**	**773090**
77	**04183 - 04199**	**0.0451**	**2.4671**	**11.3719**	**43.2337**	**0.0927**	**33.1096**	**82.6065**	**757315**
78	**04200 - 04216**	**0.0448**	**2.4281**	**11.3099**	**43.1739**	**0.074**	**31.6784**	**84.2954**	**753333**
79	**04217 - 04233**	**0.045**	**2.4844**	**11.3565**	**43.2181**	**0.0815**	**33.3948**	**82.6463**	**761187**
80	**04234 - 04250**	**0.0444**	**2.4076**	**11.4278**	**43.2886**	**0.0755**	**32.7667**	**80.4139**	**757306**
81	**04251 - 04267**	**0.0461**	**2.5871**	**11.2939**	**43.1547**	**0.0809**	**33.059**	**84.6105**	**739086**
82	**04268 - 04284**	**0.0447**	**2.3928**	**11.3346**	**43.1953**	**0.075**	**32.0057**	**83.0817**	**761552**
83	**04285 - 04301**	**0.045**	**2.424**	**11.3353**	**43.1969**	**0.0919**	**33.6228**	**82.909**	**755527**
84	**04302 - 04318**	**0.0449**	**2.437**	**11.3582**	**43.22**	**0.0962**	**34.0789**	**82.0715**	**762176**
85	**04319 - 04335**	**0.0437**	**2.3269**	**11.4547**	**43.3155**	**0.1025**	**34.4577**	**79.1597**	**763112**
86	**04336 - 04352**	**0.0444**	**2.4564**	**11.3589**	**43.2197**	**0.105**	**34.6028**	**81.8532**	**778088**

Note: The Cycle Summaries since last year's report are indicated by **bold** type.

2.2.1 Sigma0

The Sigma0 (backscatter coefficient) cycle-averages are shown in Figure 2-4. Sigma0 has remained in a band between 11.16 and 11.59 dB.

In section 2.2.7 of the May 2004 GFO Altimeter Engineering Assessment Report, we documented that the GFO Sigma0 has a small, uncorrected, dependence on receiver temperature, wherein the Sigma0's are higher with increasing temperature. George Hayne of Wallops has recently analyzed this Sigma0 temperature dependence, and has found it to be 0.033±0.003 dB per degree Centigrade. Hayne's analysis constitutes Appendix B.

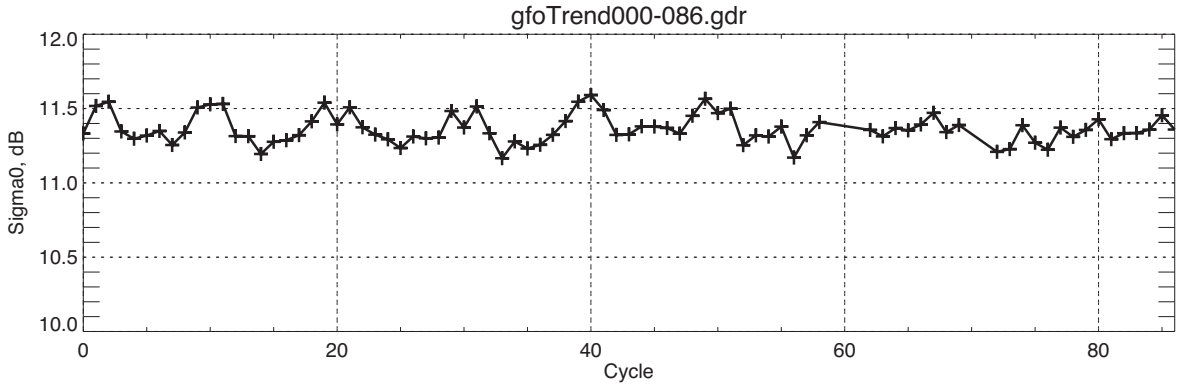

Figure 2-4 Cycle-Averages Sigma0 in dB

2.2.2 Automatic Gain Control

The automatic gain control (AGC) cycle-averages are shown in Figure 2-5. AGC has remained between 43.02 and 43.45 dB.

AGC has a direct relationship with Sigma0, in that Sigma0 is derived from the AGC; therefore, AGC has the same temperature dependence in dB/degrees as Sigma0.

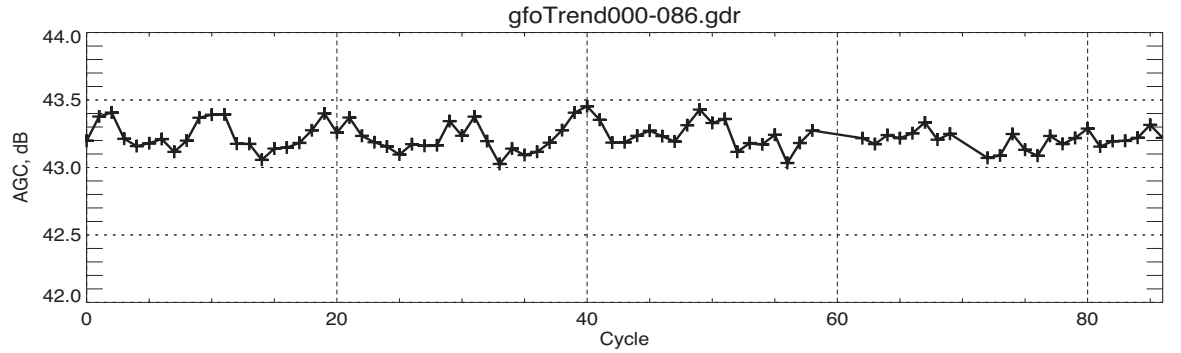

Figure 2-5 AGC Cycle-Averages in dB

2.2.3 Significant Wave Height

The significant wave height (SWH) cycle-averages are shown in Figure 2-6. SWH has remained between 2.35 and 2.67 meters.

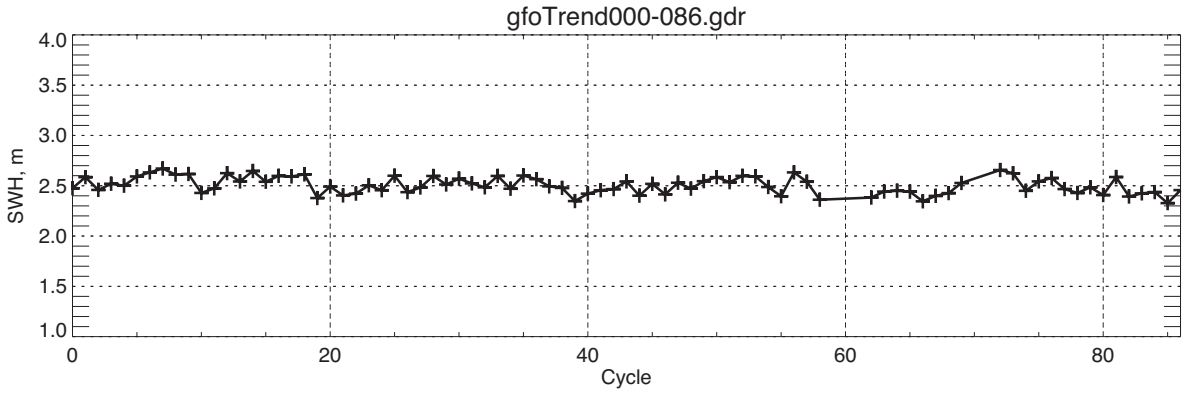

Figure 2-6 Cycle-Averages Significant Wave Height in Meters

2.2.4 Attitude

The attitude (Off-Nadir) cycle-averages are shown in Figure 2-7. Through Cycle 25, the attitude remained between 0.20 and 0.25 degrees. On day 2002057, a spacecraft attitude adjustment lowered the cycle-average attitude by approximately 0.15 degrees. Since Cycle 27, the attitude has remained between 0.07 and 0.14 degrees.

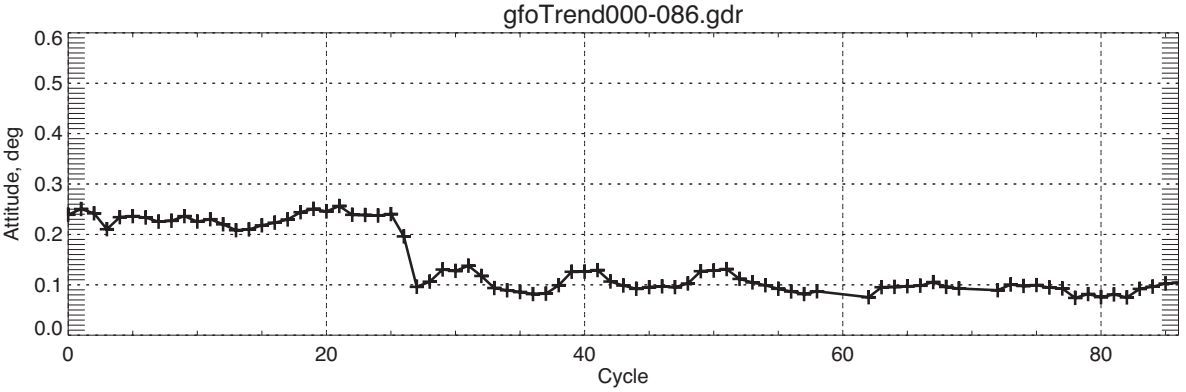

Figure 2-7 Cycle-Averages Attitude in Degrees

2.2.5 Receiver Temperature

The receiver temperature cycle-averages are shown in Figure 2-8. Receiver temperature has remained between 31.56 and 40.34 Degrees Celsius.

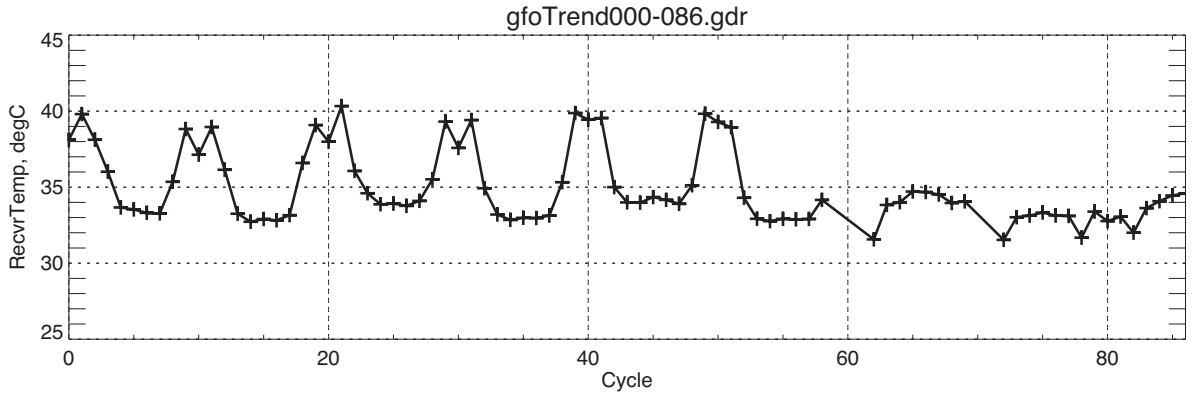

Figure 2-8 Cycle-Averages Receiver Temperature in Degrees Celsius

2.2.6 Windspeed

The windspeed cycle-averages are shown in Figure 2-9. Windspeed has remained between 7.50 and 8.85 meters/second.

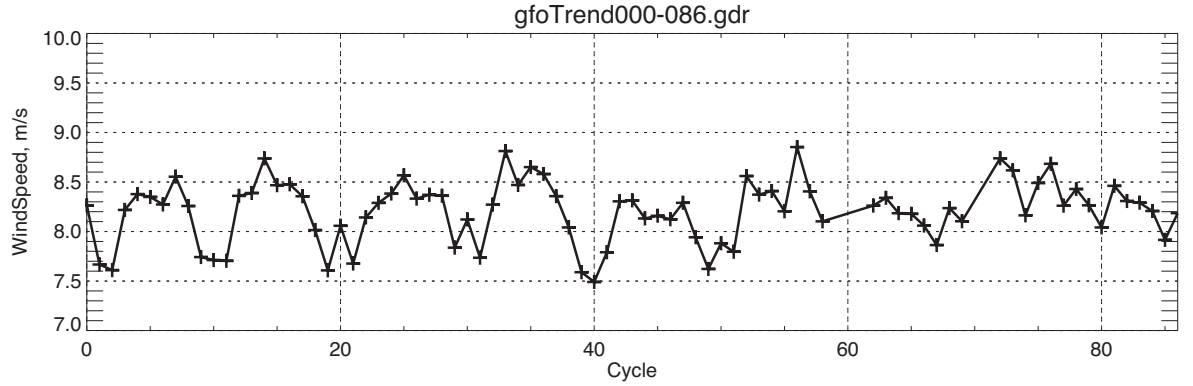

Figure 2-9 Cycle-Averages Windspeed in Meters Per Second

2.2.7 Windspeed Corrected for Sigma0 Receiver Temperature Dependence

An informal memo, "GFO Sigma0 Trends with Temperature: Analysis Efforts", by George Hayne of Wallops, Appendix B, discusses the GFO Sigma0 correlation with receiver temperature. Another informal memo, "GFO Wind Speed Correction for Sigma0 Temperature Dependence", also by George Hayne, Appendix E, describes how to correct the GFO windspeed for the receiver temperature effect on Sigma0.

Appendix E describes two methods to derive corrected windspeed. The first is to correct sigma0 then use the modified Chelton-Wentz equation to recompute windspeed. The other method is to compute a delta windspeed correction that can be added to the GFO estimate windspeed. For the data presented in this report, we corrected the GFO sigma0 then recomputed the windspeeds.

As we have noted in the past, the GFO Sigma0 has an uncorrected small instrument temperature dependence of about $\pm$0.1 dB. This is similar in magnitude to the CAL-2 dependence on temperature mentioned in Section 2.1.2. This temperature dependence is seen in Figure 2-10 depicting global Sigma0 vs. receiver temperature with a band of Sigma0 at 11.20 to 11.60, a span of 0.40 dB. Since this variation is smaller than the GFO specification, the correction has not been earlier implemented.

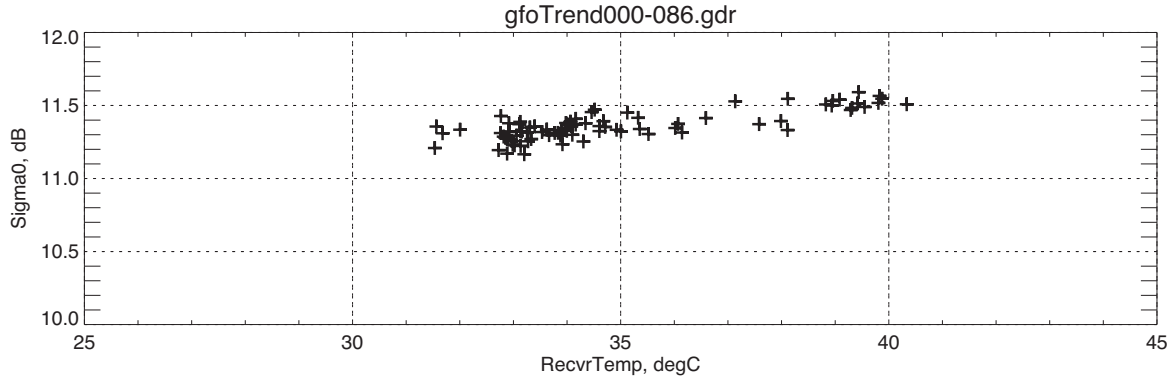

Figure 2-10 Cycle-Averages Sigma0 vs. Temperature

The propagation of the Sigma0 temperature-dependence to windspeed can be seen in the global average windspeed relationship plotted in Figure 2-11 showing a total cycle-average range of about ±0.7 meters/second. This is well within the GFO windspeed specification of 2.0 meters/second.

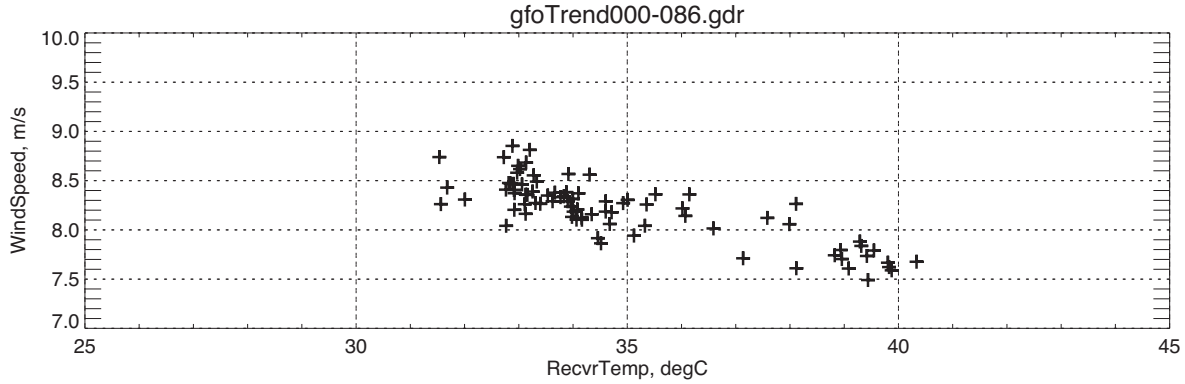

Figure 2-11 Cycle-Averages Windspeed vs. Temperature

Figure 2-12 shows the resulting cycle-average Sigma0 after being temperature corrected. Figure 2-13 shows the temperature corrected Sigma0 vs. the receiver temperature. This correction reduces the band of Sigma0 from 11.25 to 11.50, a span of 0.25 dB. Figure 2-14 shows the resulting cycle-average windspeed from using the new temperature corrected Sigma0, in the Modified Chelton-Wentz equation given in Appendix E. Figure 2-15 shows the recomputed windspeed vs. the receiver temperature with a reduced cycle-average variation of ±0.6 met ers/second.

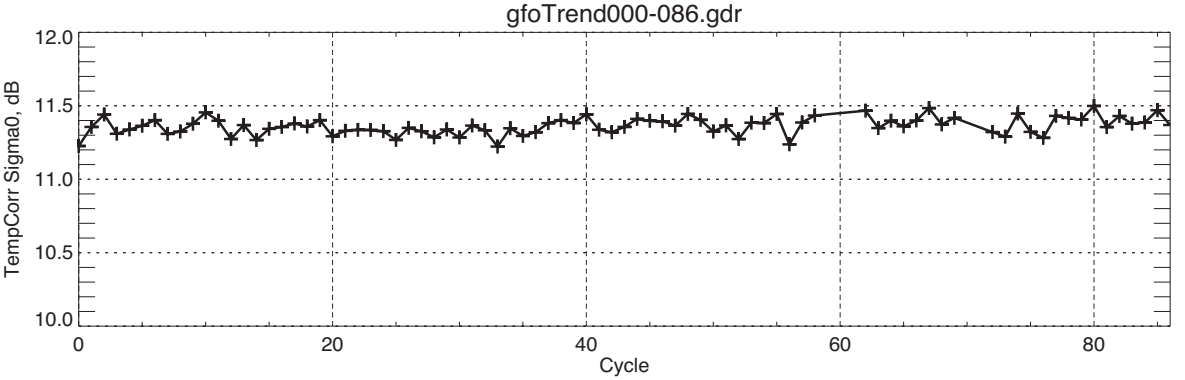

Figure 2-12 Cycle-Averages Temperature Corrected Sigma0 in dB

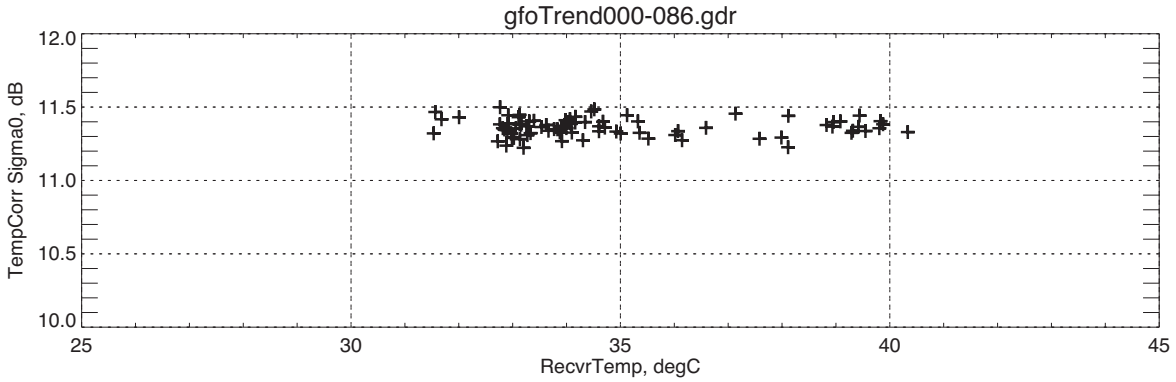

Figure 2-13 Cycle-Averages Temperature Corrected Sigma0 vs. Temperature

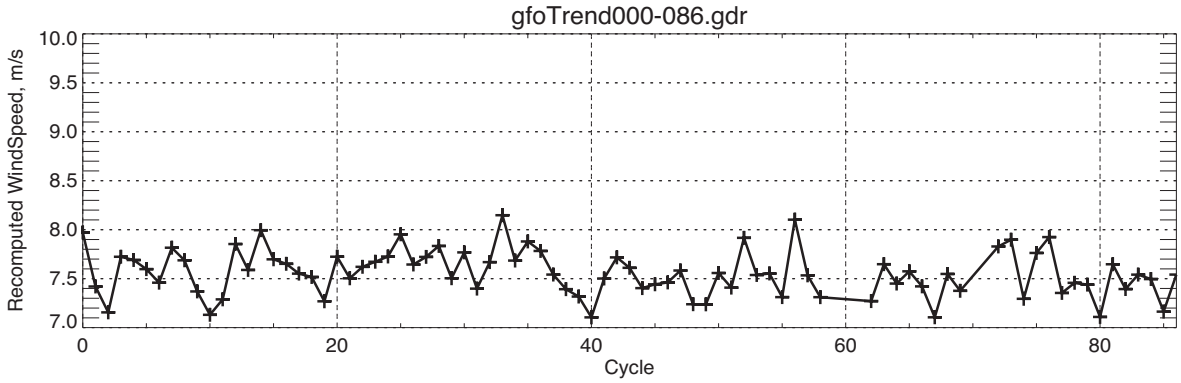

Figure 2-14 Cycle-Averages Recomputed Windspeed in Meters Per Second

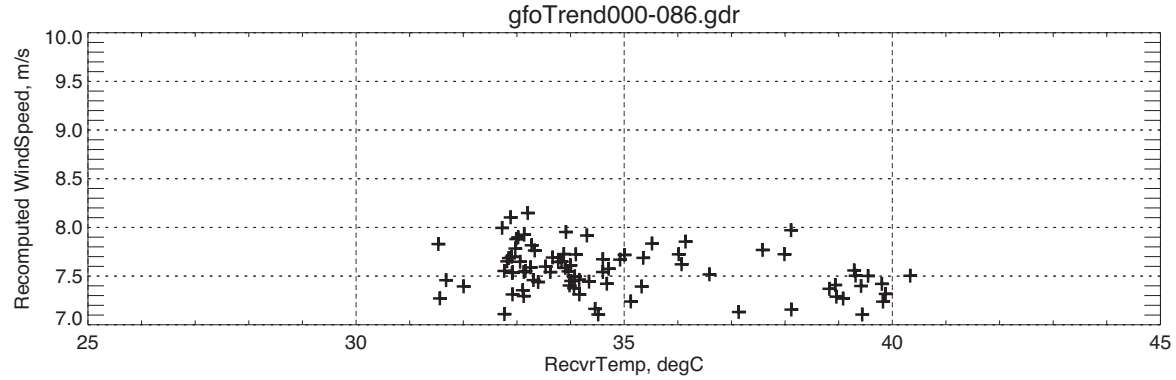

Figure 2-15 Cycle-Averages Recomputed Windspeed vs. Temperature

2.2.8 Cycle Summary Conclusions

We have previously found with TOPEX that, if the geophysical data are strictly edited, a global cycle-average of parameters provides a means of assessing cycle-to-cycle stability, and that variations can indicate changes in the altimeter instrument. Table 2-1 "GFO Cycle Summaries" on page 2-6 demonstrates similar stable performance for GFO.

The GFO Sigma0, Figure 2-4, exhibits a small temperature effect as shown in Figure 2-10. We have not applied a temperature correction to this data, but the uncorrected Sigma0 still remains within 0.5 dB, well within the 1 dB specification. It was previously recommended in the GFO Altimeter Engineering Assessment Report, From Launch to Acceptance, 10 February 1998 to 29 November 2000 that a correction be implemented.

The waveform estimated attitude (Off-Nadir), Figure 2-7, has remained stable except for the spacecraft attitude adjustment on 2002 day 057. This indicates that the data are consistent, and that the waveform samples have not changed their calibrations.

The average windspeed, Figure 2-9, is directly related to the Sigma0 and shows approximately a 1.35 meter per second variation. For calibration purposes, it is recommended the temperature correction be applied, per Appendix E, GFO Wind Speed Correction for Sigma0 Temperature Dependence; however, the raw average is better than the specification of 2 meters per second.

2.3 GFO Key Events Log

The key events log is a complete list of sensor-related events. The key events for the GFO altimeter that have occurred since the previous Engineering Assessment Report are summarized in Table 2-2. These sensor-related key events are extracted from:

http://gfo.bmpcoe.org/Gfo/Event_Log/gfo_event_log.htm

Additionally, key events from a Wallops perspective have been included. Key events that have occurred prior to December 9, 2003, are summarized in Appendix C.

Table 2-2 GFO Key Events Log (since previous report)

Event	Date & Time of Event	Comments
CPU Reset	20 Dec 2003 2003354T03:00:00Z	GFO had a spontaneous reset on 12/20 between 02:15Z & 03:09Z. This caused the satellite to go into Acquire Sun mode and turn the payload off.
Payload Operations Resumed	20 Dec 2003 2003354T22:10:00Z	Payload operations have been restored and GFO is back to its nominal Point state configuration (IAP 1). The WVR has been reinitialized, the software patch for the RA was uploaded, and the RA has started collection of data in TRK1 mode.

Table 2-2 GFO Key Events Log (Continued)
(since previous report)

Event	Date & Time of Event	Comments
ERO Maneuver	13 Jan 2004 2004013T22:22:51Z	The burn magnitude will be 2600 mm/sec with a -90 degree yaw offset. GFO out of point: 013T22:15:51Z - 013T22:31:22Z.
Trim Maneuver 1 of 2	15 Jan 2004 2004015T03:07:00Z	The burn magnitude will be 35.0 mm/sec with a 0 degree yaw offset. GFO out of point: 015T03:00:00Z - 015T03:13:00Z.
Trim Maneuver 2 of 2	15 Jan 2004 2004015T04:47:00Z	The burn magnitude will be 35.0 mm/sec with a 0 degree yaw offset. GFO out of point: 015T04:40:00Z - 015T04:53:00Z.
DDL Off	7 Feb 2004 2004038T00:00:00Z	The Direct Down Link turned off for thermal management.
Moon Intrusion	8 Feb 2004 2004039T05:42:35Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	9 Feb 2004 2004040T09:32:06Z	Momentary horizon sensor measurements errors have resulted.
Payload Secured	22 Feb 2004 2004053T19:57:00Z	The GFO payload package secured in an effort to reduce momentum wheel temperatures in preparation for solstice season. Any shift in doppler data on this date should be due to the thermal effects of turning off the payload.
Payload Powered Off	22 Feb 2004 2004053T22:00:00Z	Payloads powered off as a preventative measure and for additional satellite maintenance.
ERO Maneuver	01 Apr 2004 2004092T23:56:00Z	Maneuver to maintain the ERO during the solstice period.
Payload Powered On	09 Apr 2004 2004100T15:49:13Z	Satellite back in earth point and all payloads on and operating.
ERO Maneuver	15 Apr 2004 2004106T01:32:00Z	The burn magnitude will be 6.0 mm/sec with a 180 degree yaw offset. GFO out of point: 106T01:25:00Z - 106T01:38:00Z.
Moon Intrusion	2 May 2004 2004123T02:21:00Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	2 May 2004 2004123T04:01:50Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	2 May 2004 2004123T10:08:10Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	2 May 2004 2004123T11:48:50Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	2 May 2004 2004123T13:29:20Z	Momentary horizon sensor measurements errors have resulted.

Table 2-2 GFO Key Events Log (Continued)
(since previous report)

Event	Date & Time of Event	Comments
Moon Intrusion	2 May 2004 2004123T15:10:20Z	Momentary horizon sensor measurements errors have resulted.
ABCAL	26 Nov 2004 2004147T07:10:00Z	Performed ABCAL Maneuver: 316T07:10:00Z - 316T07:26:00Z.
Trim Maneuver	27 May 2004 2004148T01:32:00Z	The burn magnitude will be 13.54 mm/sec with a 0 degree yaw offset. GFO out of point: 148T01:25:00Z - 148T01:38:00Z.
DDL Off	19 Jul 2004 2004201T22:05:00Z	The Direct Down Link turned off for thermal management. GFO has resumed the powering-off of the transmitter in order to reduce Wheel 1 temperature and voltage. The satellite is in continual Mode 2 and will not support DDL-mode until further notice. Payload collection will continue unaffected.
Trim Maneuver	22 Jul 2004 2004204T01:05:00Z	The burn magnitude will be 13.54 mm/sec with a 0 degree yaw offset. GFO out of point: 204T00:58:00Z - 204T01:11:00Z.
DDL On	22 Jul 2004 2004204T10:17:00Z	DDL mode switching turned on and Full Wave Form (FWF) data collection resumed.
Moon Intrusion	2 Aug 2004 2004215T13:16:45Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	2 Aug 2004 2004215T14:57:05Z	Momentary horizon sensor measurements errors have resulted.
WVR Turn Off DDL Off	18 Aug 2004 2004231T20:20:00Z	Per SPAWAR's request, the operation of the Water Vapor Radiometer (WVR), the DDL mode switching, and the collection of Full Wave Form data, was suspended to control temperatures of the wheels, due to extremely high wheel voltage.
Trim Maneuver	26 Aug 2004 2004239T01:43:00Z	The burn magnitude will be 13.38 mm/sec with a 0 degree yaw offset. GFO out of point: 239T01:36:00Z - 239T01:49:00Z.
WVR Turn On	9 Sep 2004 2004253T21:45:00Z	Service restored to the Water Vapor Radiometer (WVR).
DDL On	20 Sep 2004 2004264T09:22:00Z	DDL mode switching turned on and Full Wave Form (FWF) data collection resumed.
DDL Off	21 Sep 2004 2004265T15:57:00Z	The Direct Down Link turned off and Full Wave Form data interrupted for thermal management (high wheel temperatures).
FWF Restored	29 Sep 2004 2004273T15:22:00Z	Full Wave Form (FWF) data collection resumed.

Table 2-2 GFO Key Events Log (Continued)
(since previous report)

Event	Date & Time of Event	Comments
DDL On	05 Oct 2004 2004279T23:54:00Z	DDL mode switching turned on.
DDL Off	15 Oct 2004 2004289T16:46:00Z	The Direct Down Link turned off and Full Wave Form data suspended due to ground system problems.
FWF Restored	20 Oct 2004 2004294T00:00:00Z	Full Wave Form (FWF) data collection resumed.
FWF Suspended	23 Oct 2004 2004297T15:35:00Z	Full Wave Form (FWF) data collection suspended.
Moon Intrusion	24 Oct 2004 2004298T18:49:45Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	24 Oct 2004 2004298T20:30:20Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	24 Oct 2004 2004298T22:10:50Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	25 Oct 2004 2004299T17:14:30Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	25 Oct 2004 2004299T18:55:15Z	Momentary horizon sensor measurements errors have resulted.
DDL On	27 Oct 2004 2004301T01:56:00Z	DDL mode switching turned on.
FWF Restored	27 Oct 2004 2004301T16:51:00Z	Full Wave Form (FWF) data collection resumed.
Trim Maneuver	28 Oct 2004 2004302T01:00:00Z	The burn magnitude will be 12.07 mm/sec with a 0 degree yaw offset. GFO out of point: 302T00:53:00Z - 302T01:06:00Z.
FWF Suspended	05 Nov 2004 2004310T00:00:00Z	Due to extended power outages at NAVSOC, commanding capability will be lost at NAVSOC HQ. Full Waveform Collection is being suspended.
FWF Restored	08 Nov 2004 2004313T00:00:00Z	Resumed collection of seven-hour full waveform data.
Trim Maneuver	24 Nov 2004 2004329T02:03:00Z	The burn magnitude will be 17.21 mm/sec with a 0 degree yaw offset. GFO out of point: 329T01:58:25Z - 329T02:09:00Z.

2.4 GFO Ground Processing Incident Log

The ground processing incident log is a complete list of ground processing problems. These problems are processing incidents that have been noted at NASA Wallops Flight Facility resulting from either: (a) the processing of ground data at the Payload Operations Center located at NAVOCEANO, or (b) DSU dump failures because of antenna lost telemetry and antenna failure at different Detachments.

Table 2-3 "GFO Ground Processing Incident Log (since previous report)", is the table that indicates the problems that have occurred since the previous Engineering Assessment Report. Problems that have occurred prior to December 9, 2003, are summarized in Appendix D. The majority of these problems are listed as “Segment data for.....appears to be bad”. The determination on these data is that there are more than 40 messages of “Delta Science Time Gap” per segment, indicating problems with the data. Refer to Section 2.4 GFO Ground Processing Errors, GFO Altimeter Engineering Assessment Report, The First 20 Cycles Since Acceptance, March 2002, for an example of a log for a segment of data.

The data processing errors that are listed as “Segment data for.....appears to be bad” are caused, on the most part, by noisy data in the Payload data file received from the DSU download at NAVSOC. The eng, ra, ra-cal, and wvf data are not filtered for noise, by the direction from the CALVAL team. The CALVAL team wanted to receive the data in the same manner as it is received at the Payload Operations Center (POC).

Table 2-3 GFO Ground Processing Incident Log (since previous report)

Data Type	Data Date	Comments
Support Resumed	13 December 2003 - 2003347	Resumed collection of seven-hour full waveform data.
RA	17 December 2003 - 2003351	Segment data for ra 03351_15_10_53 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 351t15:10 to 351t18:18.
SCC Generation Anomaly	10 January 2004 - 2004010	An anomaly was discovered regarding the generation of SCCs. It was found that SCCs generated and distributed after 0615Z on 10-Jan-2004 are invalid due to noisy timing data resulting from a possible hardware failure. Ground system personnel suspect the GPS receiver at DetA. SCCs are generated from timing data originating from only the DetA TTCS.
RA	15 January 2004 - 2004015	Segment data for ra 04015_20_19_07 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 015t20:19 to 015t23:41.
RA	22 January 2004 - 2004022	Segment data for ra 04022_18_35_04 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 022t21:11 to 023t02:11.

Table 2-3 GFO Ground Processing Incident Log (Continued)
(since previous report)

Data Type	Data Date	Comments
RA	5 February 2004 - 2004036	Segment data for ra 04036_17_13_10 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 036t17:13 to 036t21:06.
RA	6 February 2004 - 2004037	Segment data for ra 04037_00_29_59 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 037t00:29 to 037t04:23.
RA	11 February 2004 - 2004042	Segment data for ra 04042_17_43_40 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 042t17:43 to 042t22:41.
RA	12 February 2004 - 2004043	Segment data for ra 04043_18_34_55 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 043t18:34 to 043t22:10.
RA	16 April 2004 - 2004107	Segment data for ra 04107_02_48_33 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 107t02:48 to 107t06:00.
Communications Failure	29 April 2004 - 2004120	A total communication failure on both classified POC machines. NAVO System Administrator has found an issue with the DECnet software (communication software at NAVO).
Communications Restored	30 April 2004 - 2004121	NAVO returned to operational status @ 13:00. NAVSOC sent all Payload data which spanned NAVO's downtime. No loss of data, all data was processed and sent out.
Reduced Support	13 May 2004 - 2004134	NAVSOC experienced some problems with both Det A and Laguna Peak (LP) and will be collecting data from only one station instead of three stations. Due to this anomaly, there will only be an interruption in the Full WF data for 24 hours.
RA	25 June 2004 - 2004177	Segment data for ra 04177_11_29_03 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 177t11:29 to 177t14:36.
RA	04 July 2004 - 2004186	Received invalid ra segment 04070_07_00_24. Set of CALVAL files corrupted at the beginning of file.
RA	12 July 2004 - 2004194	Segment data for ra 04194_11_00_50 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 194t11:00 to 194t15:49.

Table 2-3 GFO Ground Processing Incident Log (Continued) (since previous report)

Data Type	Data Date	Comments
Reduced Support	20 July 2004 - 2004202	The GFO RA (RA Track 3 mode) changed to the two 10-minute RA calibrations per day and suspended Full-waveform data collection. The reduction of FWF data is due to ground station hardware problems at Det A and an unknown cause at Laguna Peak suffering RFI.
Support Resumed	22 July 2004 - 2004204	Resumed collection of seven-hour full waveform data at 204t1017Z.
Reduced Support	18 August 2004 - 2004231	The GFO RA (RA Track 3 mode) changed to the two 10-minute RA calibrations per day and suspended Full-waveform data collection. The suspension of FWF data is to control temperatures of the wheels, due to extremely high wheel voltage.
RA	19 August 2004 - 2004232	Segment data for ra 04232_14_51_09 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 232t14:59 to 232t19:53.
RA	26 August 2004 - 2004239	Received invalid ra segment 07170_10_10_04. Set of CALVAL files corrupted at the beginning of file.
Support Resumed	20 September 2004 - 2004264	Resumed collection of seven-hour full waveform data at 264t0922Z.
Reduced Support	21 September 2004 - 2004265	During support at DET A DOY 2004265 the DDL mode was turned off and RA CAL FWF data collection was interrupted. These configuration changes were made to reduce temperatures on the GFO satellite. RA CAL sequences are planned to be resumed DOY 2004266.
Reduced Support	23 September 2004 - 2004267	The GFO RA (RA Track 3 mode) changed to the two 10-minute RA calibrations per day and suspended Full-waveform data collection. The reduction of FWF data is due to ground station hardware problems at Det A.
RA	27 September 2004 - 2004271	Received invalid ra segment 04067_10_18_38. Set of CALVAL files corrupted at the beginning of file.
Support Resumed	29 September 2004 - 2004273	Resumed collection of seven-hour full waveform data.
Support Resumed	05 October 2004 - 2004279	Resumed DDL mode-switching operations.

Table 2-3 GFO Ground Processing Incident Log (Continued)
(since previous report)

Data Type	Data Date	Comments
Reduced Support	15 October 2004 - 2004289	Due to the consecutive loss of passes at Det C and LP still being down due to Y-axis motor repair, NAVSOC has only one reliable ground station for GFO OPS. Hence, to minimize risk of losing DSU data, NAVSOC will turn off Full WaveForm (FWF) Data 2004289 (15 OCT 04) and loss of FWF data will take effect 2004290 (16 OCT 04). DDL mode was also suspended.
Support Resumed	20 October 2004 - 2004294	Resumed collection of seven-hour full waveform data.
Reduced Support	23 October 2004 - 2004297	Due to ground systems issues at LP and Dec C, Full Waveform Collection is being suspended.
Support Resumed	27 October 2004 - 2004301	Resumed DDL mode-switching operations and collection of seven-hour full waveform data.
RA	28 October 2004 - 2004302	Received invalid ra segment 04060_11_46_08. Set of CALVAL files corrupted at the beginning of file.
Reduced Support	05 November 2004 - 2004310	Due to extended power outages at NAVSOC, commanding capability will be lost at NAVSOC HQ. Full Waveform Collection is being suspended.
Support Resumed	08 November 2004 - 2004313	Resumed collection of seven-hour full waveform data.
RA	08 November 2004 - 2004313	Segment data for ra 04313_21_12_02 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 313t21:12 to 314t00:19.
RA	15 November 2004 - 2004320	Received invalid ra segment 04057_19_49_36. Set of CALVAL files corrupted at the beginning of file.
RA	03 December 2004 - 2004338	Segment data for ra 04338_03_37_47 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 338t03:37 to 338t07:42.
RA	15 December 2004 - 2004350	Received invalid ra segment 04070_07_00_29. Set of CALVAL files corrupted at the beginning of file.

Section 3

Assessment of Instrument Performance

The following sub-sections report several assessments performed by the WFF GFO team. All analysis indicates the altimeter instrument is performing within pre-launch specifications.

Section 3.1 addresses the range noise performance. Section 3.2 shows the groundtrack coverage of full-waveform GFO data for a typical 17-day cycle; these data are acquired for ice studies over southern Greenland. Then, Section 3.3 provides both an update on CAL-2 waveforms and an analysis of GFO's attitude (off-nadir) angles.

3.1 Range Measurement Noise

The GEOSAT Follow-on (GFO) altimeter white noise levels have been evaluated using the technique based on high-pass filtering of 1-Hz sea surface height time series. Refer to Assessment of the Cycle-Per-Cycle Noise Level of the GEOSAT Follow-On, TOPEX, and POSEIDON Altimeters, *Journal of Atmospheric and Oceanic Technology*, December 2002, (http://gfo.wff.nasa.gov; select Documents; select Publications). High-pass filtering removes the geoid and oceanography signals while revealing the random noise. This filtering technique is simpler to use than the repeat-track method, gives essentially the same results, and makes it easier to analyze much larger amounts of data to investigate subtle variations in noise levels. The noise level measurements provided here all show a stable noise process from cycle-to-cycle with a linear dependence of the noise level upon significant waveheight (SWH). The GFO altimeter noise level is estimated to be about 2.57 cm for an SWH of 2m. The average altimeter noise level of 2.57 has been consistent over the 87 cycles. Table 3-1 summarizes the results.

The data used for Table 3-1 had slightly different data editing criteria than the data that were used in Section 2. The cycle "SWH Mean" is the SWH for the data used in each cycle, and the "Noise Level Mean" is the mean of the noise estimated by the high-pass filter method. The "Noise Level at 2m SWH" is the noise estimate from fitting the individual noise estimate as a function, then solving the fitted equation for a "2m SWH".

Table 3-1 Statistical Indicators for GFO Based on 1-Minute Track Segments

Time Period			SWH (m)		Noise Level (cm)		
Cycle	Cycle Start Date	Cycle End Date	Mean	STD	Mean	STD	at 2m SWH
01	2000-352	2001-002	2.629	1.221	2.996	1.162	2.542
02	2001-003	2001-019	2.506	1.185	2.903	1.115	2.547
03	2001-020	2001-036	2.552	1.158	3.044	1.271	2.680
04	2001-037	2001-053	2.520	1.144	2.914	1.108	2.545
05	2001-054	2001-070	2.603	1.237	3.006	1.149	2.596
06	2001-071	2001-087	2.644	1.231	3.022	1.123	2.592
07	2001-088	2001-104	2.680	1.242	3.032	1.136	2.573
08	2001-105	2001-121	2.600	1.252	2.962	1.115	2.563
09	2001-122	2001-138	2.605	1.326	3.015	1.212	2.590
10	2001-139	2001-155	2.466	1.258	2.886	1.153	2.560
11	2001-156	2001-172	2.504	1.261	2.906	1.145	2.557
12	2001-173	2001-189	2.674	1.401	3.047	1.282	2.567
13	2001-190	2001-206	2.583	1.379	3.007	1.247	2.599
14	2001-207	2001-223	2.699	1.406	3.059	1.259	2.572
15	2001-224	2001-240	2.561	1.293	2.953	1.161	2.569
16	2001-241	2001-257	2.626	1.435	3.009	1.261	2.572
17	2001-258	2001-274	2.623	1.343	3.006	1.190	2.583
18	2001-275	2001-291	2.612	1.287	2.998	1.164	2.581
19	2001-292	2001-308	2.379	1.141	2.813	1.069	2.552
20	2001-309	2001-325	2.488	1.165	2.898	1.102	2.567
21	2001-326	2001-342	2.404	1.077	2.818	1.023	2.546
22	2001-343	2001-359	2.441	1.143	2.857	1.097	2.555
23	2001-360	2002-011	2.480	1.199	2.922	1.150	2.583
24	2002-012	2002-028	2.453	1.183	2.858	1.108	2.544
25	2002-029	2002-045	2.575	1.198	2.946	1.118	2.553
26	2002-046	2002-062	2.422	1.094	2.820	1.035	2.539
27	2002-063	2002-079	2.500	1.166	2.892	1.074	2.552

Table 3-1 Statistical Indicators for GFO Based on 1-Minute Track Segments (Continued)

Time Period			SWH (m)		Noise Level (cm)		
Cycle	Cycle Start Date	Cycle End Date	Mean	STD	Mean	STD	at 2m SWH
28	2002-080	2002-096	2.608	1.161	2.972	1.103	2.554
29	2002-097	2002-113	2.504	1.217	2.910	1.100	2.574
30	2002-114	2002-130	2.558	1.252	2.959	1.158	2.572
31	2002-131	2002-147	2.543	1.289	2.956	1.215	2.564
32	2002-148	2002-164	2.517	1.245	2.935	1.165	2.573
33	2002-165	2002-181	2.612	1.353	2.989	1.231	2.559
34	2002-182	2002-198	2.513	1.314	2.921	1.206	2.559
35	2002-199	2002-215	2.653	1.427	3.026	1.255	2.579
36	2002-216	2002-232	2.634	1.400	2.994	1.221	2.557
37	2002-233	2002-249	2.527	1.299	2.941	1.162	2.582
38	2002-250	2002-266	2.546	1.366	2.959	1.189	2.591
39	2002-267	2002-283	2.415	1.141	2.859	1.092	2.571
40	2002-284	2002-300	2.482	1.196	2.921	1.112	2.597
41	2002-301	2002-317	2.499	1.228	2.905	1.133	2.569
42	2002-318	2002-334	2.497	1.148	2.905	1.101	2.558
43	2002-335	2002-351	2.545	1.197	2.967	1.143	2.587
44	2002-352	2003-003	2.427	1.143	2.856	1.087	2.564
45	2003-004	2003-020	2.515	1.208	2.941	1.139	2.588
46	2003-021	2003-037	2.439	1.128	2.859	1.057	2.562
47	2003-038	2003-054	2.527	1.226	2.954	1.141	2.594
48	2003-055	2003-071	2.479	1.161	2.921	1.119	2.586
49	2003-072	2003-072	2.535	1.220	2.943	1.085	2.597
50	2003-089	2003-105	2.564	1.255	2.988	1.159	2.603
51	2003-106	2003-122	2.510	1.228	2.938	1.145	2.590
52	2003-123	2003-139	2.576	1.285	2.962	1.171	2.565
53	2003-140	2003-156	2.594	1.343	3.014	1.241	2.597
54	2003-157	2003-173	2.513	1.351	2.961	1.233	2.605
55	2003-174	2003-190	2.430	1.296	2.878	1.165	2.583

Table 3-1 Statistical Indicators for GFO Based on 1-Minute Track Segments (Continued)

Time Period			SWH (m)		Noise Level (cm)		
Cycle	Cycle Start Date	Cycle End Date	Mean	STD	Mean	STD	at 2m SWH
56	2003-191	2003-207	2.692	1.423	3.032	1.229	2.568
57	2003-208	2003-224	2.582	1.447	2.981	1.251	2.587
58	2003-225	2003-241	2.398	1.355	2.851	1.201	2.577
59	2003-242	2003-258					
60	2003-259	2003-275					
61	2003-276	2003-292					
62	2003-293	2003-309	2.404	1.208	2.842	1.104	2.575
63	2003-310	2003-326	2.473	1.118	2.888	1.071	2.563
64	2003-327	2003-343	2.483	1.186	2.915	1.141	2.573
65	**2003-344**	**2003-360**	**2.479**	**1.091**	**2.898**	**1.055**	**2.579**
66	**2003-361**	**2004-012**	**2.367**	**1.124**	**2.796**	**1.057**	**2.548**
67	**2004-013**	**2004-029**	**2.411**	**1.175**	**2.873**	**1.099**	**2.592**
68	**2004-030**	**2004-046**	**2.46**	**1.168**	**2.877**	**1.093**	**2.564**
69	**2004-047**	**2004-063**	**2.536**	**1.278**	**2.961**	**1.182**	**2.594**
72	**2004-098**	**2004-114**	**2.653**	**1.307**	**3.065**	**1.212**	**2.61**
73	**2004-115**	**2004-131**	**2.582**	**1.258**	**2.979**	**1.14**	**2.588**
74	**2004-132**	**2004-148**	**2.444**	**1.347**	**2.878**	**1.194**	**2.574**
75	**2004-149**	**2004-165**	**2.556**	**1.332**	**2.961**	**1.192**	**2.581**
76	**2004-166**	**2004-182**	**2.607**	**1.394**	**2.991**	**1.247**	**2.568**
77	**2004-183**	**2004-199**	**2.51**	**1.371**	**2.93**	**1.198**	**2.587**
78	**2004-200**	**2004-216**	**2.449**	**1.375**	**2.894**	**1.206**	**2.587**
79	**2004-217**	**2004-233**	**2.513**	**1.331**	**2.936**	**1.207**	**2.584**
80	**2004-234**	**2004-250**	**2.448**	**1.282**	**2.945**	**1.199**	**2.632**
81	**2004-251**	**2004-267**	**2.602**	**1.395**	**3**	**1.245**	**2.588**
82	**2004-268**	**2004-284**	**2.429**	**1.214**	**2.859**	**1.103**	**2.57**
83	**2004-285**	**2004-301**	**2.456**	**1.14**	**2.875**	**1.079**	**2.564**
84	**2004-302**	**2004-318**	**2.442**	**1.11**	**2.855**	**1.054**	**2.557**
85	**2004-319**	**2004-335**	**2.359**	**1.105**	**2.802**	**1.059**	**2.561**

Table 3-1 Statistical Indicators for GFO Based on 1-Minute Track Segments (Continued)

Time Period			SWH (m)		Noise Level (cm)		
Cycle	Cycle Start Date	Cycle End Date	Mean	STD	Mean	STD	at 2m SWH
86	**2004-336**	**2004-352**	**2.481**	**1.170**	**2.898**	**1.122**	**2.563**
Note: The statistical indicators since last update are indicated by **bold** type.							

3.2 Groundtrack Coverage for GFO Full-Waveform Data

On 2001, day 171 (June 20), GFO started collecting full waveform data over Greenland. Collection of these waveforms was agreed upon to help study altimeter acquisition times and for the study of changes in the Greenland icesheet.

Because of the limited GFO ground commanding and the fact that all Greenland passes occur on consecutive orbits, it was decided to implement the waveform collection in conjunction with the two daily commanded calibration modes. After the first calibration mode, the GFO altimeter stays in the long format for a duration of five hours and collects waveforms until the second calibration mode is executed. Once the second calibration is completed, the long format is continued for an additional duration of two hours of waveform collection.

Daily, the first calibration mode is commanded prior to the first Greenland overpass and the second calibration mode is commanded five hours later. This provides approximately 7 hours of continuous waveform data per day and provides waveforms for all the ascending and descending passes over Greenland. Figure 3-1 "17 Days of Track Data over Greenland" shows the coverage for 17 days (1 cycle) of data over Greenland.

The collection of full waveform data since 2001-171 has been for 1276 days.

There was a total of 275 days of reduced support as indicated in Table 3-2 "Reduced Support for Full Waveforms". See Table 2-3 and Appendix D, GFO Ground Processing Incident Log, for more details.

3.3 Additional Observations

3.3.1 Calibration Mode 2 Waveforms

It was noted in the “GFO Altimeter Engineering Assessment Report, From Launch to Acceptance” that Calibration Mode 2 data should consist of flat waveforms, but the pre-launch data exhibited a “smile” pattern, with both ends of the waveform being higher than the middle. This “smile” introduces errors during normal processing. A software patch (Smile Patch) was developed to correct this by flattening the waveform. During the period from launch to acceptance there were several resets that necessitated the “smile patch” be reloaded.

During the period from acceptance to the end of this reporting period, there have been occurrences of resets that turn the payloads off resulting in the loss of the software patch (smile patch). Once the payloads were turned back on and the software patch had been loaded, however, data collection resumed, without any additional data having the “smile” effect.

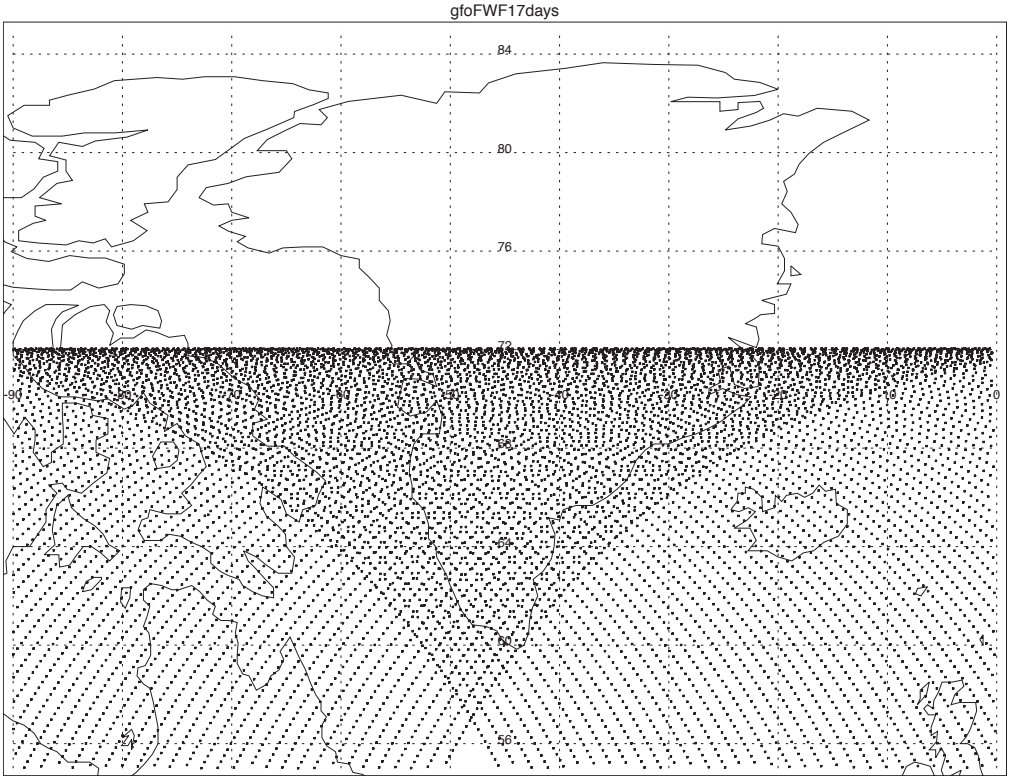

Figure 3-1 17 Days of Track Data over Greenland

Table 3-2 Reduced Support for Full Waveforms

Beginning Date Reduced Support	Duration Days	Reason for Turn OFF
2002-330	6	ground systems at LP
2002-339	79	typhoon destroyed antenna Det C
2003-109	6	antenna at LP down
2003-200	11	antenna at LP not functional
2003-227	5	ground system at Det C
2003-249	51	CPU reset, satellite in safemode
2003-336	4	CPU reset, satellite in sun acquire mode

Table 3-2 Reduced Support for Full Waveforms

Beginning Date Reduced Support	Duration Days	Reason for Turn OFF
2003-354	1	CPU reset, satellite in sun acquire mode
2004-053	48	Payloads Off
2004-134	1	problems at Det A & LP
2004-202	2	ground station hardware problems at Det A
2004-231	34	control temperature of the wheels due to high wheel voltage
2004-265	9	high wheel temperatures and ground system hardware problems at Det A
2004-288	9	ground system problems at Det C & LP
2004-297	5	ground system issues at Det C & LP
2004-310	4	extended power outage at NAVSOC
	Total=275 Days	

3.3.2 Attitude

It was noted in the "GFO Altimeter Engineering Assessment Report, The First 20 Cycles Since Acceptance"dated March 2002, that there were much higher than usual numbers of attitudes that were above 0.3 degrees.

It was recommended by WFF that an attitude adjustment be performed. On 2002057, mid-Cycle 26, a spacecraft attitude change was performed by the GFO Project to lower the attitude. In Figure 3-2 "Daily-Averages Attitude in Degrees", the averaged daily attitude is shown from time of acceptance to 17 December, 2004.

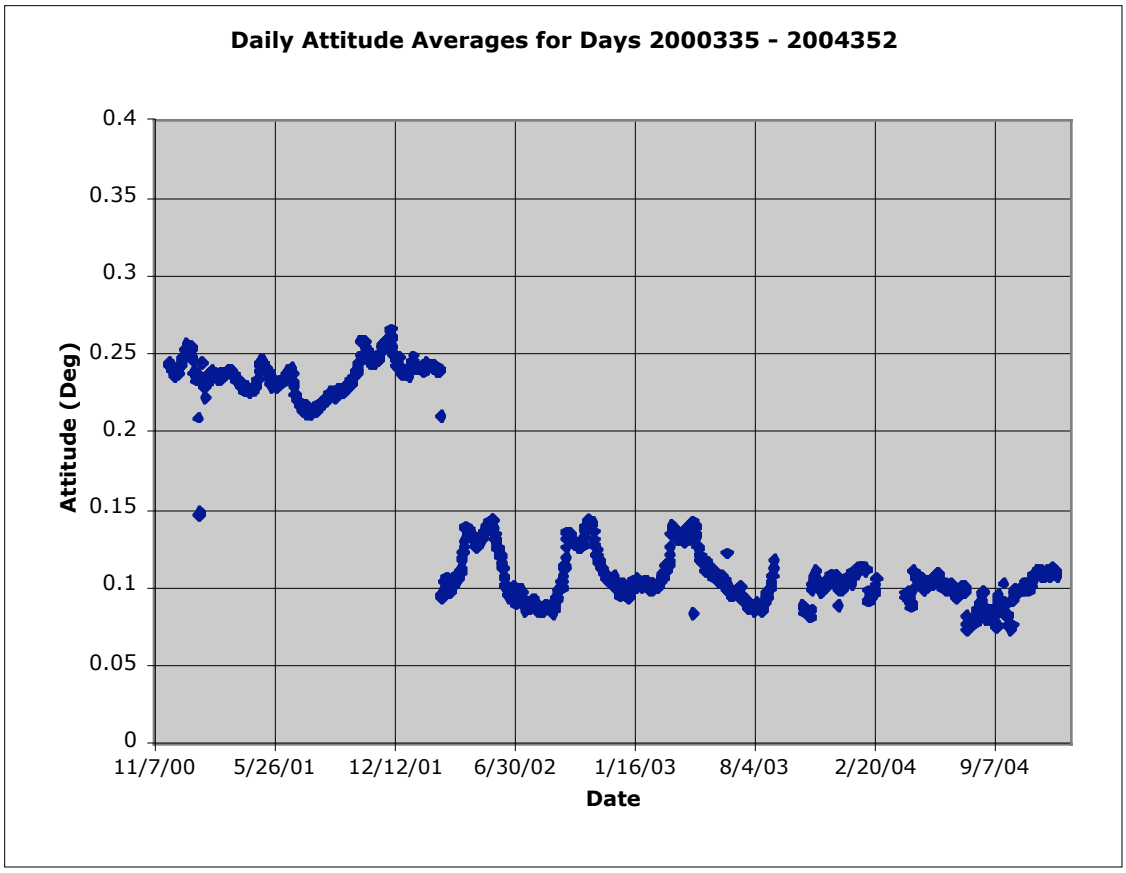

Figure 3-2 Daily-Averages Attitude in Degrees

In the “GFO Altimeter Engineering Assessment Report, Update: The First 43 Cycles Since Acceptance” dated April 2003, Section 3.3.2 Attitude, the large number of high attitudes (off-nadir angles) were described for various cycles. This was to illustrate a need for an attitude adjustment, by showing the high number of attitudes that were above 0.3 degrees. The attitude was lowered on day 2002057. In the “GFO Altimeter Engineering Assessment Report, Update: The First 65 Cycles Since Acceptance”, dated May 2004, Section 3.3.2 (Attitude), illustrated that the large number of attitudes above 0.3 degrees had been reduced, while the number of attitudes above 0.2 degrees had increased. Since last year’s report, the number of high attitudes above 0.3

degrees has had no significant change, but the high attitudes above 0.2 degrees have increased slightly. The four sets of figures; Figures 3-3 and 3-4 (Cycle 67, January 2004), Figures 3-5 and 3-6 (Cycle 73, April 2004), Figures 3-7 and 3-8 (Cycle 79, August 2004), Figures 3-9 and 3-10 (Cycle 85, November 2004), represent the seasons, with the six cycle differentials each representing 102 days. In each pair of figures, the first plot shows the number of attitudes above 0.2 degrees, and the second plot shows the number of attitudes above 0.3 degrees. By comparison, it reflects that the attitude adjustment has significantly reduced the number of high attitudes above 0.3 degrees.

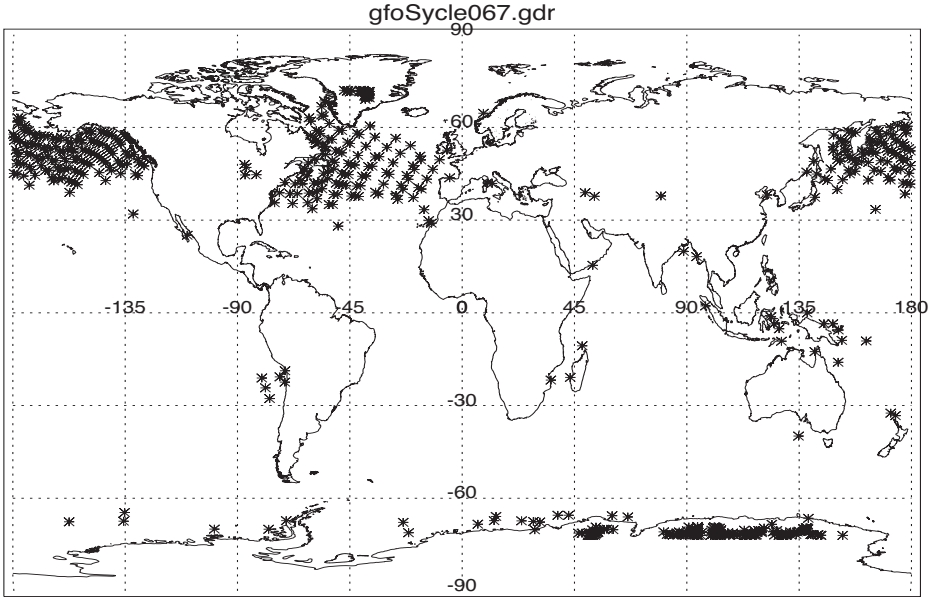

Figure 3-3 Attitude > 0.2 Degree, Cycle 67

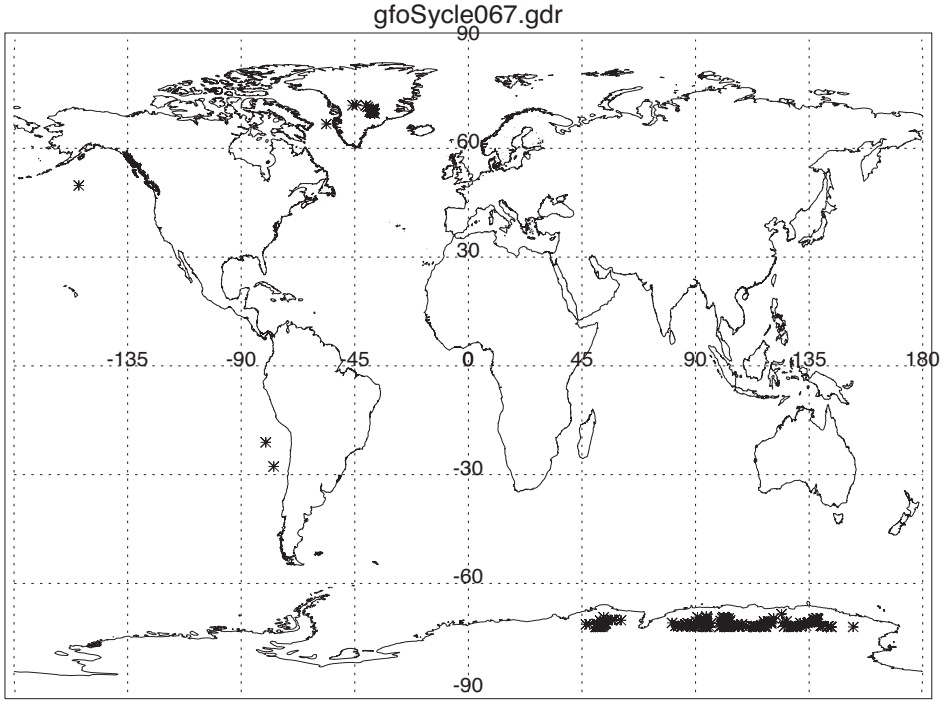

Figure 3-4 Attitude > 0.3 Degree, Cycle 67

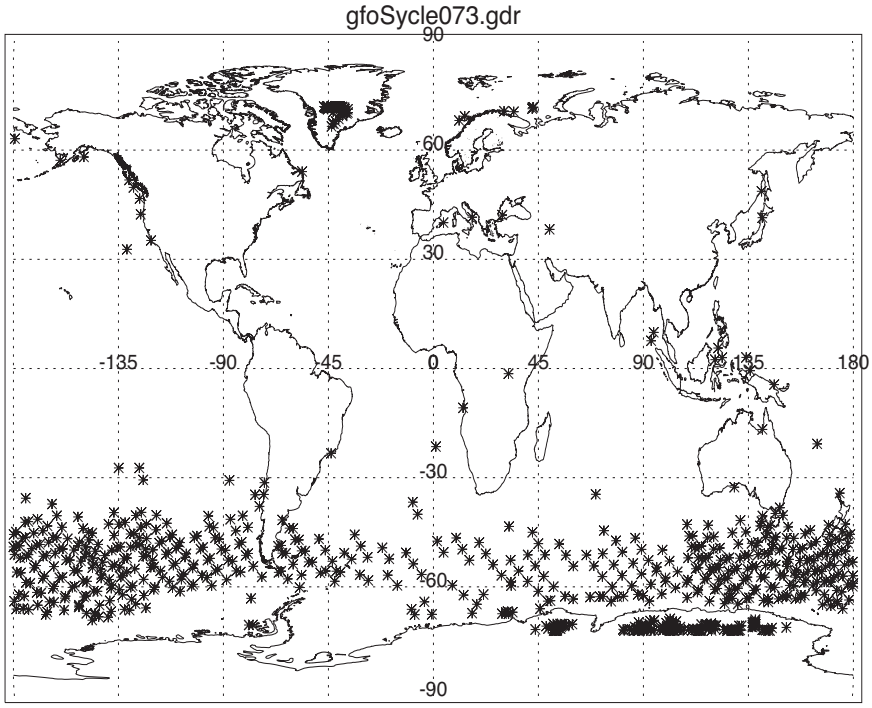

Figure 3-5 Attitude > 0.2 Degree, Cycle 73

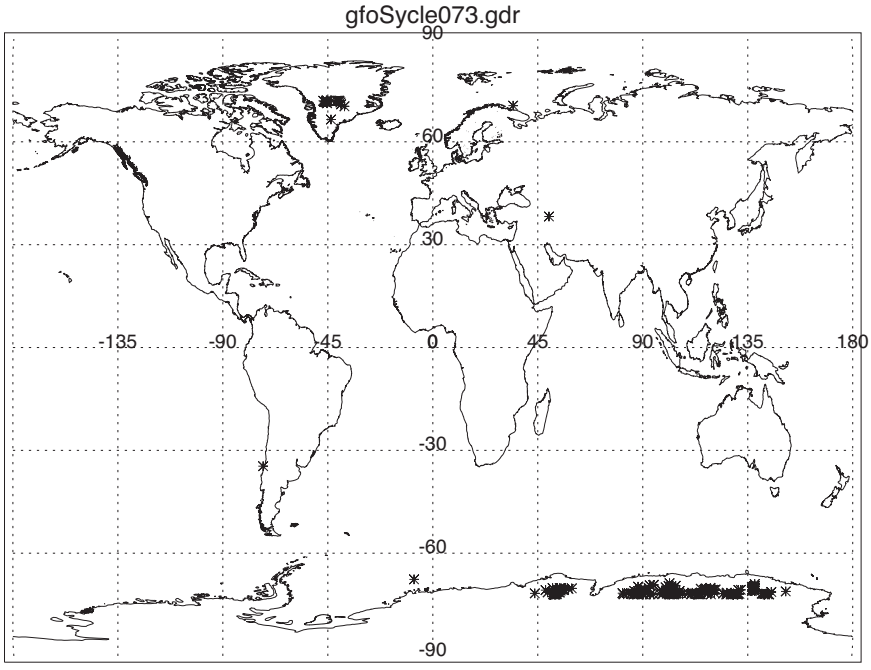

Figure 3-6 Attitude > 0.3 Degree, Cycle 73

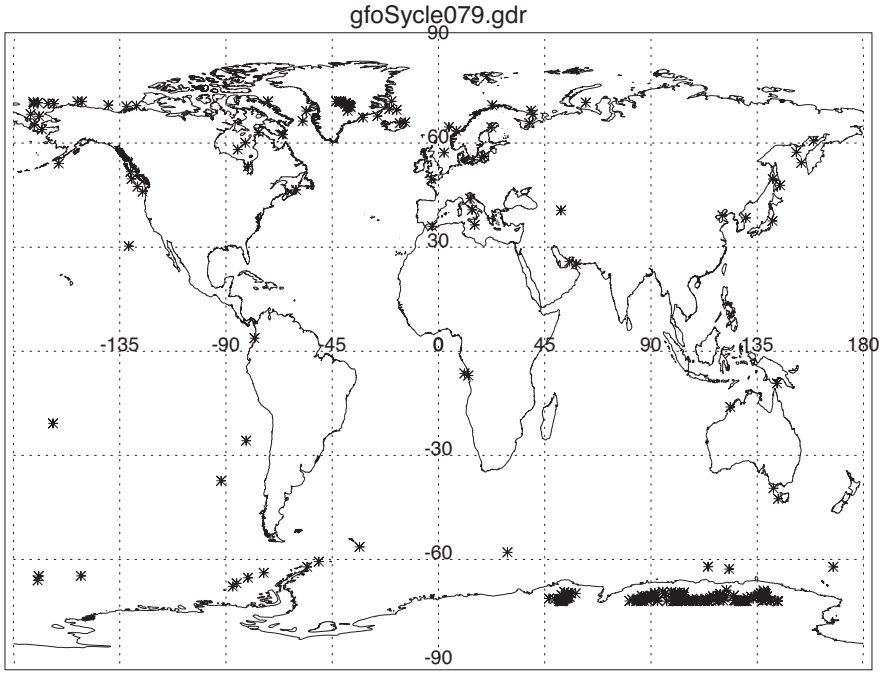

Figure 3-7 Attitude > 0.2 Degree, Cycle 79

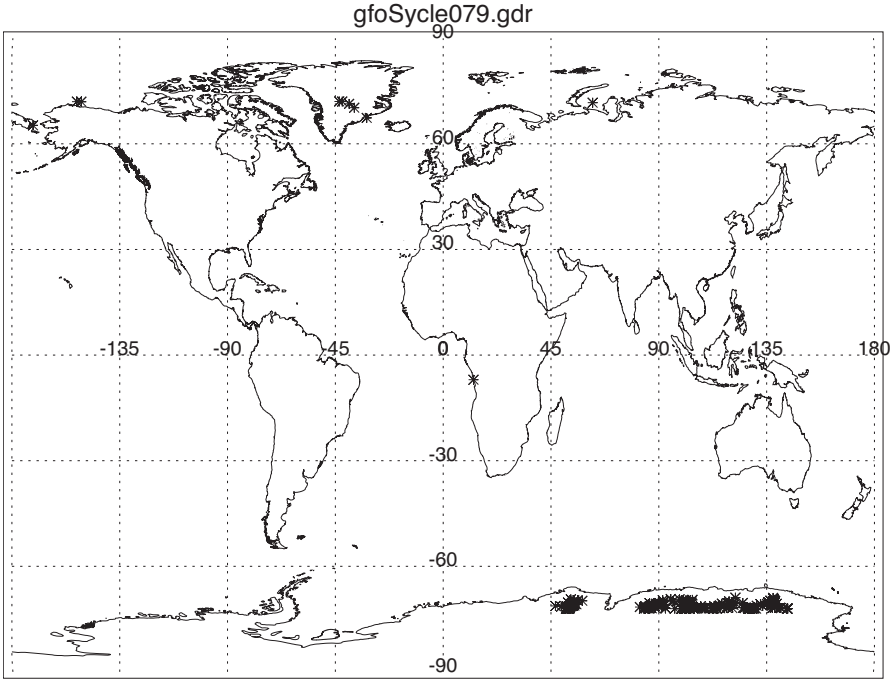

Figure 3-8 Attitude > 0.3 Degree, Cycle 79

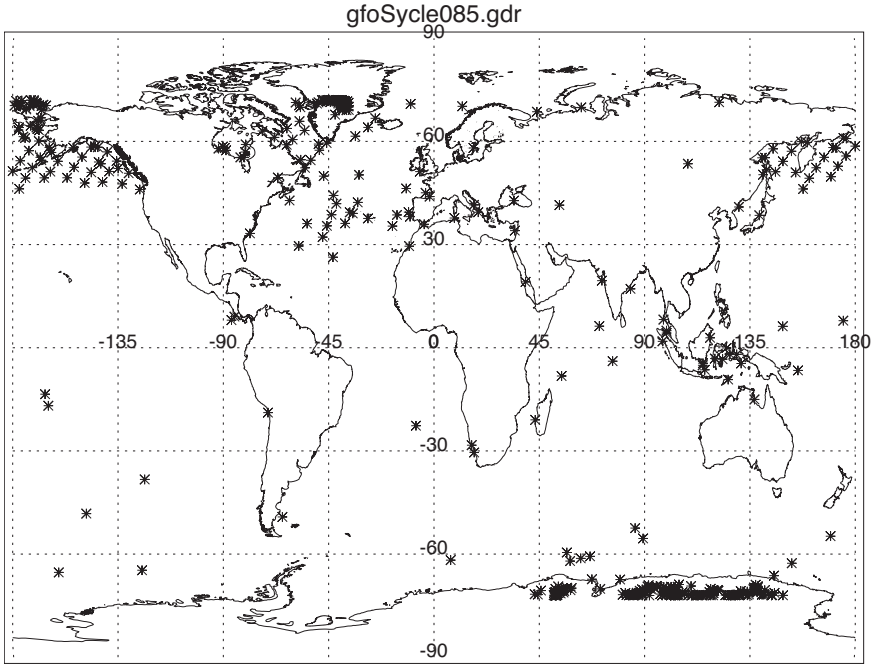

Figure 3-9 Attitude > 0.2 Degree, Cycle 85

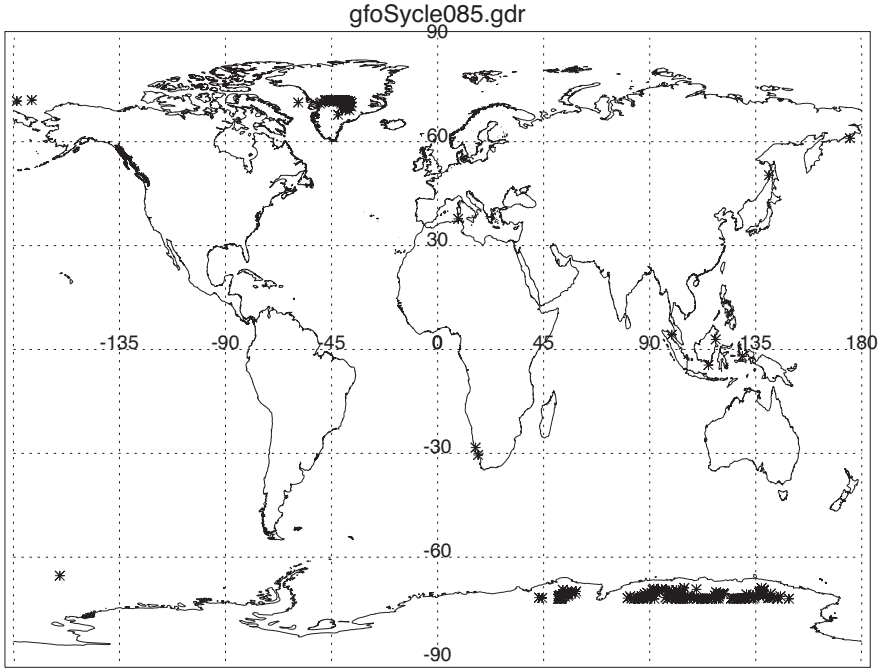

Figure 3-10 Attitude > 0.3 Degree, Cycle 85

Section 4

Other Studies

4.1 GFO Altimeter Windspeed Monitoring

As part of the validation of GFO data, we monitor the surface windspeed retrieved from the radar cross-section measurements for possible trends. This analysis helps to check the proper functioning of the GFO instrument related to the altimeter return power estimation. For that purpose we use the National Centers for Environmental Prediction (NCEP) winds. The data and method of calculation was noted in the "GFO Altimeter Assessment Report, The First 20 Cycles Since Acceptance".

Table 4-1 "Statistical Indicators", provides the cycle-per-cycle statistical indicators. The comparison shows small biases between GFO and NCEP windspeeds. The averaged bias for a cycle range is between -0.5 m/s and +0.7 m/s, a 1.2 m/s spread.

Figure 4-1 "Plot of Selected Statistical Indicators from Table 4-1" on page 4-5, shows the variations of the averaged value of Sigma0, SWH, GFO windspeed and NCEP windspeed.

Column Definitions for Table 4-1 Statistical Indicators	
year	Year at the Beginning of the Cycle
cycle	Equivalent to Exactly 17 Days
limit 1	Averaged Value of NCEP - STD NCEP
limit 2	Averaged Value of NCEP + STD NCEP
$<\sigma_0>$	Averaged Value of Sigma0
<SWH>	Averaged Value of SWH
<Ugfo>	Averaged Value of GFO Windspeed
<Uncep>	Averaged Value of NCEP Windspeed
<Ugfo> - <Uncep>	Averaged GFO Windspeed - Averaged NCEP Windspeed

Table 4-1 Statistical Indicators

year	cycle	limit 1 (m/s)	limit2 (m/s)	$<\sigma_0>$ (dB)	<SWH> (m)	$<U_{gfo}>$ (m/s)	$<U_{ncep}>$ (m/s)	$<U_{gfo}> - <U_{ncep}>$
2001	1	4.865	11.122	11.526	2.334	7.236	7.618	-0.382
2001	2	4.862	10.885	11.543	2.229	7.190	7.521	-0.331
2001	3	5.039	11.055	11.284	2.313	8.051	7.793	0.258
2001	4	4.896	10.846	11.269	2.288	8.103	7.604	0.499
2001	5	4.558	10.960	11.369	2.307	7.803	7.355	0.448

Table 4-1 Statistical Indicators (Continued)

year	cycle	limit 1 (m/s)	limit2 (m/s)	$<\sigma_0>$ (dB)	<SWH> (m)	$<U_{gfo}>$ (m/s)	$<U_{ncep}>$ (m/s)	$<U_{gfo}> - <U_{ncep}>$
2001	6	4.498	10.902	11.412	2.327	7.673	7.337	0.336
2001	7	4.746	11.207	11.275	2.413	8.115	7.682	0.433
2001	8	4.836	11.054	11.398	2.278	7.678	7.646	0.032
2001	9	4.660	10.990	11.585	2.258	7.067	7.432	-0.365
2001	10	4.667	10.856	11.566	2.124	7.134	7.379	-0.245
2001	11	4.768	11.025	11.537	2.173	7.213	7.578	-0.365
2001	12	4.968	11.353	11.312	2.312	7.949	7.786	0.163
2001	13	4.740	10.997	11.319	2.233	7.952	7.505	0.447
2001	14	4.836	11.223	11.205	2.326	8.334	7.656	0.678
2001	15	4.763	11.150	11.292	2.239	8.031	7.607	0.424
2001	16	4.534	11.256	11.342	2.255	7.899	7.487	0.412
2001	17	4.627	11.230	11.375	2.247	7.775	7.486	0.289
2001	18	4.694	11.024	11.481	2.287	7.390	7.459	-0.069
2001	19	4.648	10.778	11.589	2.104	7.035	7.365	-0.330
2001	20	4.842	10.962	11.433	2.215	7.544	7.578	-0.034
2001	21	4.909	10.871	11.533	2.156	7.182	7.620	-0.438
2001	22	4.789	10.881	11.366	2.191	7.765	7.518	0.247
2002	23	4.729	10.814	11.372	2.210	7.744	7.376	0.368
2002	24	4.819	10.863	11.291	2.199	8.029	7.559	0.470
2002	25	4.777	11.064	11.280	2.309	8.061	7.604	0.457
2002	26	4.668	10.797	11.366	2.150	7.783	7.384	0.399
2002	27	4.710	11.168	11.333	2.219	7.903	7.589	0.314
2002	28	4.796	11.183	11.337	2.337	7.877	7.730	0.147
2002	29	4.709	10.966	11.520	2.184	7.259	7.575	-0.316
2002	30	4.917	11.123	11.405	2.251	7.617	7.703	-0.086
2002	31	4.578	11.090	11.551	2.203	7.156	7.430	-0.274
2002	32	4.844	11.079	11.345	2.190	7.823	7.617	0.206
2002	33	5.049	11.397	11.153	2.301	8.477	7.881	0.596
2002	34	4.743	11.058	11.284	2.172	8.053	7.507	0.546
2002	35	4.737	11.418	11.248	2.264	8.186	7.665	0.521
2002	36	4.769	11.349	11.239	2.272	8.210	7.679	0.531

Table 4-1 Statistical Indicators (Continued)

year	cycle	limit 1 (m/s)	limit2 (m/s)	$<\sigma_0>$ (dB)	<SWH> (m)	$<U_{gfo}>$ (m/s)	$<U_{ncep}>$ (m/s)	$<U_{gfo}> - <U_{ncep}>$
2002	37	4.676	11.142	11.316	2.207	7.958	7.575	0.383
2002	38	4.648	11.198	11.436	2.160	7.554	7.503	0.051
2002	39	4.977	10.996	11.499	2.148	7.300	7.737	-0.437
2002	40	4.642	10.916	11.599	2.173	7.006	7.417	-0.411
2002	41	4.847	11.046	11.468	2.201	7.404	7.662	-0.258
2002	42	4.915	10.957	11.304	2.245	7.970	7.674	0.296
2002	43	4.721	4.721	11.335	2.275	7.881	7.490	0.391
2002	44	4.699	10.811	11.368	2.160	7.768	7.441	0.327
2003	45	4.637	11.076	11.364	2.241	7.793	7.514	0.279
2003	46	4.729	10.813	11.351	2.192	7.815	7.509	0.306
2003	47	4.628	11.081	11.359	2.247	7.807	7.501	0.306
2003	48	4.579	10.955	11.442	2.233	7.534	7.450	0.084
2003	49	4.401	11.073	11.660	2.198	6.869	7.366	-0.497
2003	50	4.597	11.181	11.529	2.258	7.239	7.567	-0.328
2003	51	4.588	10.934	11.551	2.182	7.167	7.437	-0.270
2003	52	4.865	11.147	11.267	2.270	8.089	7.721	0.368
2003	53	4.464	10.986	11.378	2.249	7.751	7.303	0.448
2003	54	4.496	11.133	11.361	2.155	7.822	7.376	0.446
2003	55	4.488	10.810	11.396	2.112	7.704	7.319	0.385
2003	56	4.921	11.556	11.163	2.330	8.465	7.920	0.545
2003	57	4.486	11.334	11.369	2.174	7.799	7.456	0.343
2003	58	4.468	11.093	11.452	2.016	7.514	7.389	0.125
2003	59							
2003	60							
2003	61							
2003	62	4.467	10.753	11.378	2.097	7.744	7.263	0.481
2003	63	4.780	10.948	11.302	2.222	7.974	7.560	0.414
2003	64	4.589	11.056	11.379	2.184	7.757	7.451	0.306
2003	**65**	**4.807**	**10.929**	**11.341**	**2.234**	**7.835**	**7.571**	**0.264**
2003	**66**	**4.766**	**10.920**	**11.372**	**2.108**	**7.731**	**7.554**	**0.177**
2004	**67**	**4.401**	**10.845**	**11.515**	**2.124**	**7.303**	**7.220**	**0.083**

Table 4-1 Statistical Indicators (Continued)

year	cycle	limit 1 (m/s)	limit2 (m/s)	$<\sigma_0>$ (dB)	<SWH> (m)	$<U_{gfo}>$ (m/s)	$<U_{ncep}>$ (m/s)	$<U_{gfo}> - <U_{ncep}>$
2004	**68**	**4.837**	**11.220**	**11.322**	**2.191**	**7.904**	**7.710**	**0.194**
2004	**69**	**4.576**	**11.110**	**11.439**	**2.217**	**7.532**	**7.463**	**0.069**
2004	**70**							
2004	**71**							
2004	**72**	**4.651**	**11.244**	**11.223**	**2.357**	**8.270**	**7.661**	**0.609**
2004	**73**	**4.774**	**10.991**	**11.271**	**2.271**	**8.078**	**7.572**	**0.506**
2004	**74**	**4.334**	**10.855**	**11.454**	**2.081**	**7.519**	**7.176**	**0.343**
2004	**75**	**4.702**	**11.111**	**11.317**	**2.202**	**7.937**	**7.540**	**0.397**
2004	**76**	**4.738**	**11.559**	**11.229**	**2.270**	**8.258**	**7.808**	**0.450**
2004	**77**	**4.418**	**11.212**	**11.413**	**2.129**	**7.662**	**7.424**	**0.238**
2004	**78**	**4.624**	**11.166**	**11.368**	**2.049**	**7.784**	**7.523**	**0.261**
2004	**79**	**4.781**	**11.282**	**11.358**	**2.176**	**7.794**	**7.699**	**0.095**
2004	**80**	**4.557**	**11.035**	**11.470**	**2.091**	**7.445**	**7.377**	**0.068**
2004	**81**	**4.807**	**11.341**	**11.322**	**2.224**	**7.923**	**7.705**	**0.218**
2004	**82**	**4.659**	**11.005**	**11.337**	**2.106**	**7.867**	**7.476**	**0.391**
2004	**83**	**4.674**	**10.925**	**11.342**	**2.176**	**7.848**	**7.520**	**0.328**
2004	**84**	**4.648**	**10.836**	**11.380**	**2.170**	**7.719**	**7.454**	**0.265**
2004	**85**	**4.518**	**10.806**	**11.461**	**2.088**	**7.478**	**7.352**	**0.126**
2004	**86**	**4.662**	**11.157**	**11.371**	**2.208**	**7.750**	**7.570**	**0.180**
	Note: The statistical indicators since last update are indicated by **bold** type.							

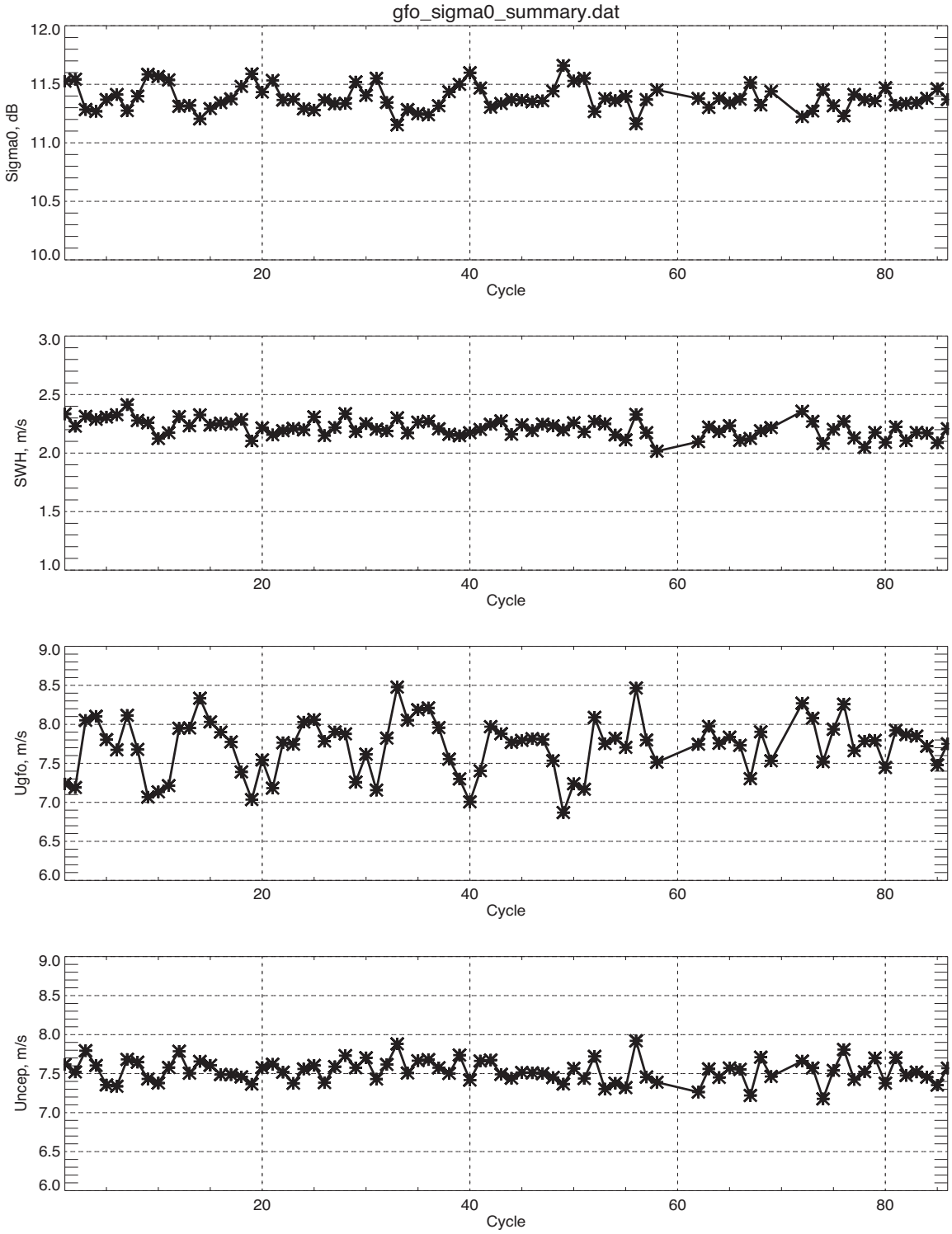

Figure 4-1 Plot of Selected Statistical Indicators from Table 4-1

Section 2.2.7, Windspeed Corrected for Sigma0 Receiver Temperature Dependence, discusses how to correct the GFO windspeed for the receiver temperature effect on Sigma0.

In Figure 4-2 "Plots of Temperature Corrected Sigma0 and Recomputed Windspeed", we show the temperature corrected Sigma0 (in the top plot), the recomputed GFO windspeed using the Modified Chelton-Wentz algorithm (in the middle plot), and the delta between the recomputed GFO windspeed and the NCEP windspeed (in the bottom plot). The total span of the difference of the recomputed windspeed is less than 1.2 m/s whereas the span of the difference for the uncorrected windspeed, on the NGDR, is 1.6 m/s. This illustrates the improved performance of the recomputed windspeed from the temperature corrected Sigma0.

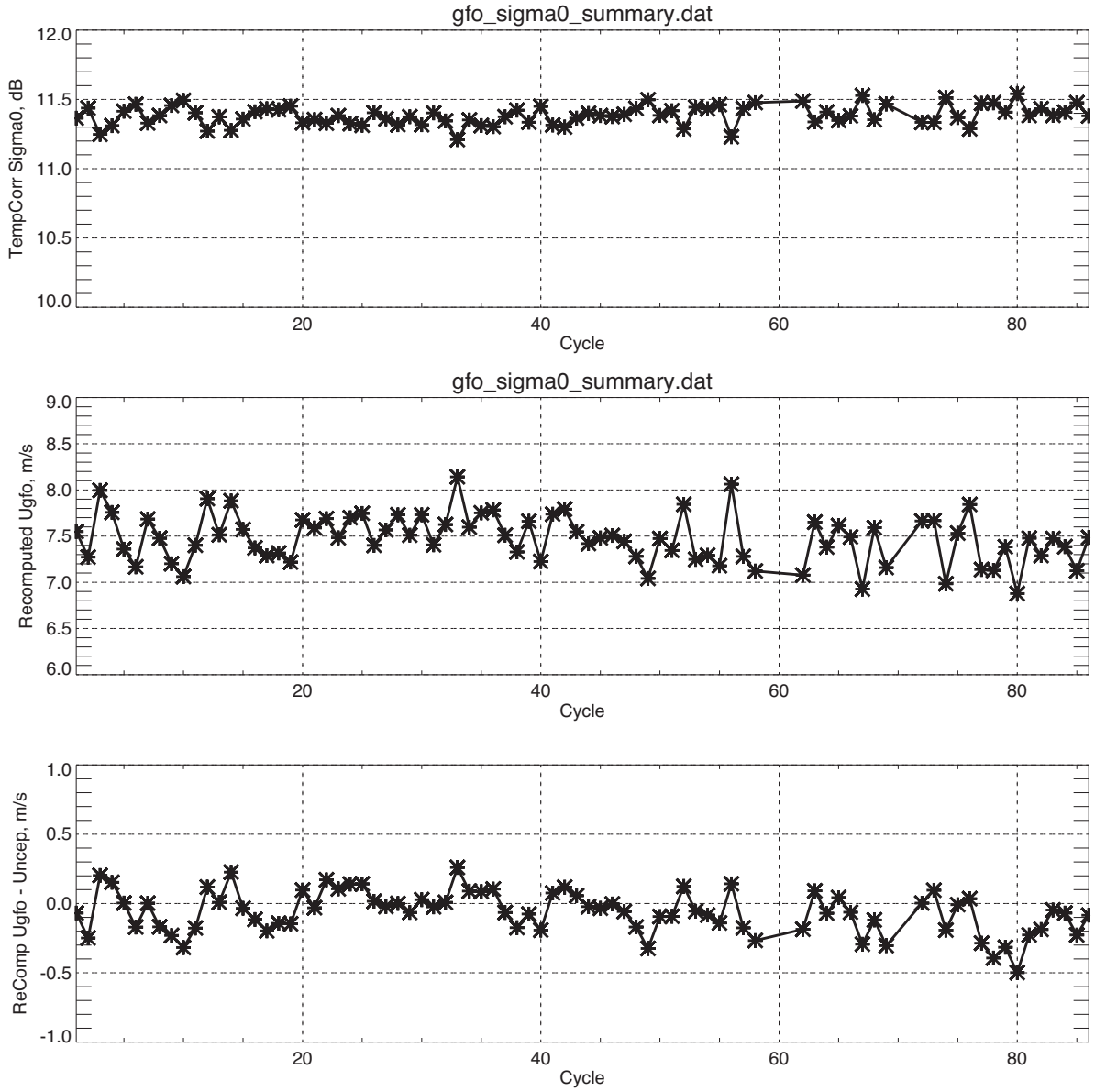

Figure 4-2 Plots of Temperature Corrected Sigma0 and Recomputed Windspeed

4.2 Altimeter Boresight Calibration Maneuvers

Early in GFO's on-orbit operation, an altimeter boresight calibration (also called attitude bias calibration) maneuver (ABCAL) was executed to verify that the satellite attitude control system was adequately maintaining nadir pointing of the altimeter antenna's boresight axis. The GFO ABCAL sequence was described in more detail in the "GFO Altimeter Engineering Assessment Report Update: The First 43 Cycles Since Acceptance", April 2003, Section 4.3 and Appendix B. In 2004, a single ABCAL was performed on 26 May 2004, and that ABCAL's results are briefly summarized here.

The GFO altimeter performed well throughout the entire time of the ABCAL, reporting significant waveheight values from 1 to 4.5 meters with sigma0 values lower than 15 dB. There were no apparent sigma0 blooms in this data span. The usual WFF waveform fits were performed for 2-second averages of GFO waveforms in the ABCAL. Figure 4-3 "GFO SWH Estimates and Gate Index Values in 2004/05/26 ABCAL" shows the SWH values from the GFO NGDR product and from the WFF waveform fits, and Figure 4-4 "GFO NGDR Sigma0 Estimates" shows the sigma0 values from the GFO NGDR.The waveform fit attitude estimates were compared to the

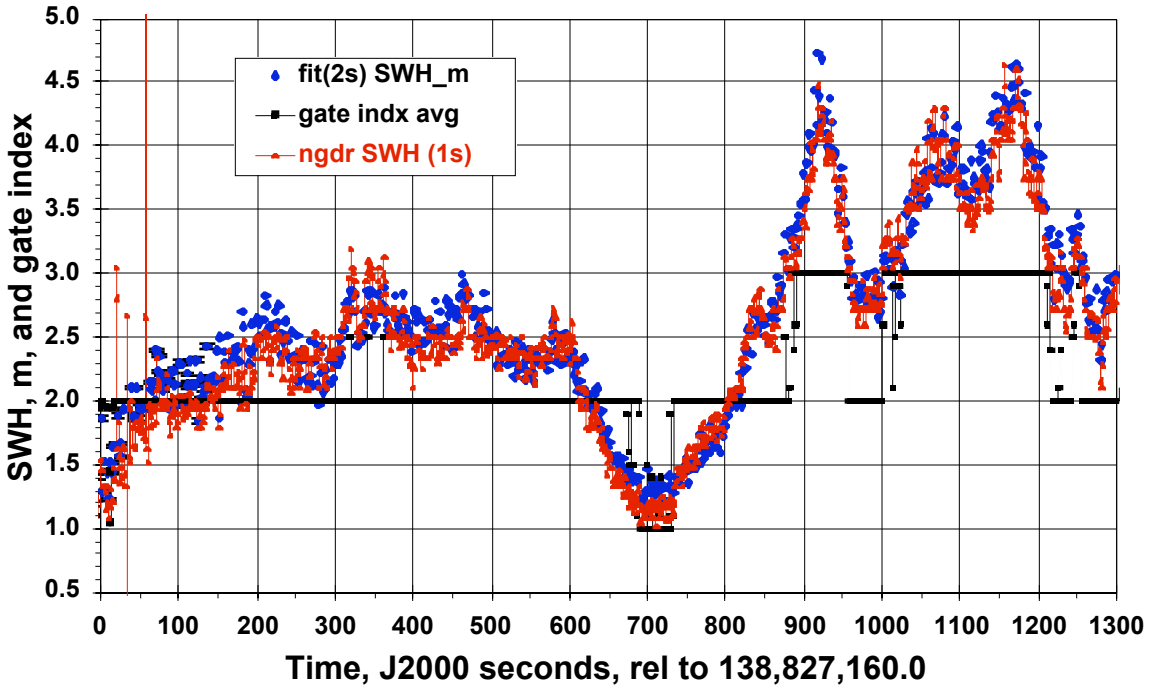

Figure 4-3 GFO SWH Estimates and Gate Index Values in 2004/05/26 ABCAL

spacecraft attitude control system data (provided to WFF by Lance Pritikin (lance.pritikin@navy.mil) of General Dynamics at NAVSOC on 26 May), and a new boresight vector solution was obtained in the same manner as described in earlier GFO ABCALS. The new boresight vector estimated x, y, z components are -0.17060024, -0.00031568, and 0.98534028 (dimensionless, as these are direction cosines).

Figure 4-5 "Waveform Fit and Calculated Attitudes in 2004/05/26 ABCAL from WFF Boresight Vector Solution" is the summary figure showing the fitted and calculated attitudes for the 26 May 2004 GFO ABCAL.

From the near symmetry of the attitude excursions in Figure 4-5, it was concluded that the GFO attitude control system has a very small attitude bias, and that no further attitude zero adjustment was needed at that time.

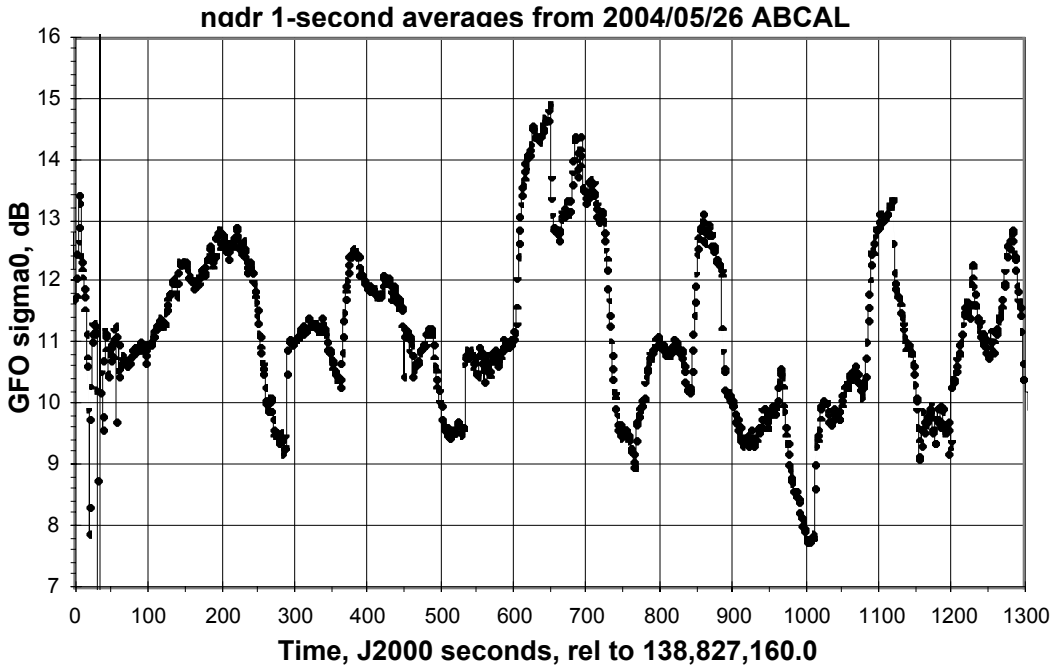

Figure 4-4 GFO NGDR Sigma0 Estimates

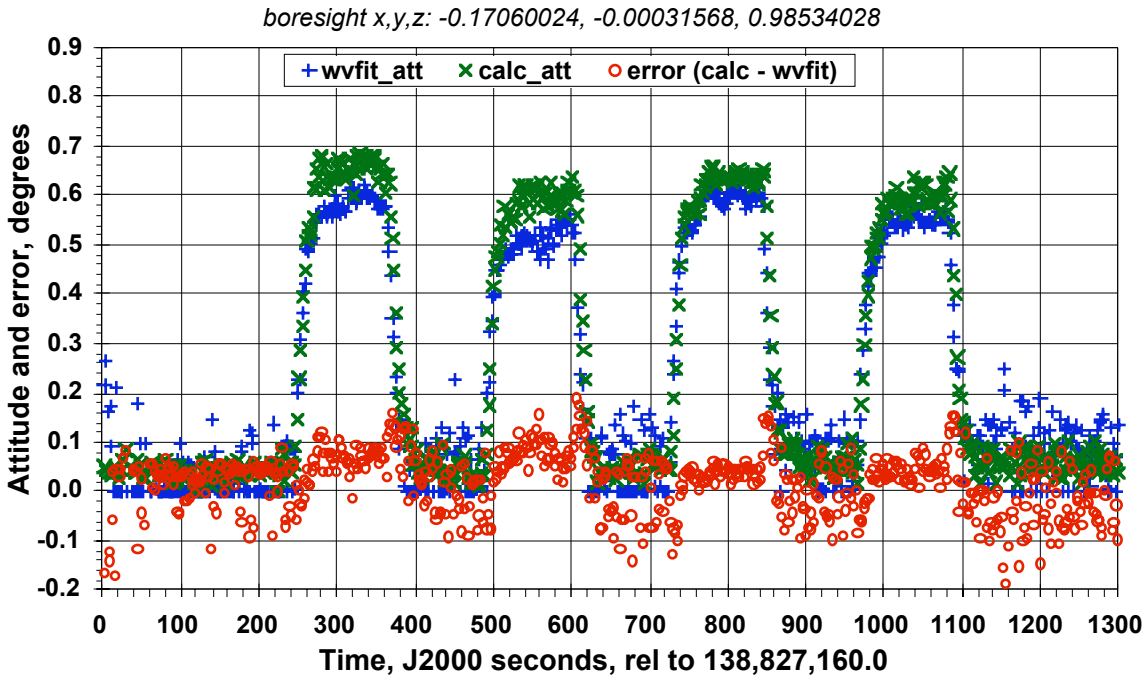

Figure 4-5 Waveform Fit and Calculated Attitudes in 2004/05/26 ABCAL from WFF Boresight Vector Solution

Section 5

WFF's Recommendation to GFO Project

5.1 GFO Wind Speed Correction for Sigma0 Temperature Dependence

The WFF team recommends that the GFO ground processing system implements a correction to sigma0 for the residual effect of receiver temperature; this correction will improve the accuracy of the wind speed estimates. The correction details are provided in appendices B and E. Corrected sigma0 in terms of the receiver temperature is provided by:

$$Corrected\_Sigma0 = Sigma0 + (T_{ref} - T_{receiver})* 0.033$$

where Temperatures (T) are in degrees C, and sigma0 is in dB and the recommended value for T_{ref} is 34 degrees C.

Users may correct existing data by either of the equations defined in appendix E. If users have sigma0 and receiver temperature, then they can correct sigma0 and use the Modified Chelton-Wentz equation to recompute the windspeed. If users have only the receiver temperature (an estimated cycle average could be used) and GFO wind speed, then the [D(windspeed)/D(Sigma0)] approach can be used to compute the additive corrections to the GFO wind speed.

Section 6

Engineering Assessment Synopsis

6.1 Performance Overview

Our analyses of the GFO altimeter demonstrate that it is performing well. Its range measurement precision is comparable with contemporaneous satellite radar altimeters, including TOPEX and JASON-1. Its internal calibrations and its cycle-to-cycle global averages have been very consistent. Comparisons with other sensors indicate that measurement biases are well within GFO's pre-flight specifications of: SWH $\pm$0.5m, Sigma0 $\pm$1 dB, and Windspeed $\pm$2 m/s.

In our prior years' reporting, we described a very minor range dependency on sensor temperature, of less than 1 mm per degree. That temperature dependency has been decreasing as shown in Section 2.1.1 and, at the end of this performance assessment period, is insignificant. We will continue to monitor the dependency.

A windspeed dependency on sensor temperature was discussed last year. This year's report contains a more detailed investigation that provides a recommended correction algorithm.

We are continuing our GFO altimeter performance assessment on a daily basis. Supplemental performance reports will be issued on a regular basis, and special reports will be prepared as warranted.

Section 7

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Appendix A

Cumulative Index of Studies

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GFO Sigma0 Comparison of GFO and TOPEX - *GFO Altimeter Engineering Assessment Report, From Launch to Acceptance*, NASA/TM-2001-209984/Ver.1/Vol.1, March 2001.

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Appendix B
GFO Sigma0 Trends with Temperature: Analysis Efforts

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Raytheon ITSS

23 November 2004

Introduction and Conclusion

The May 2004 GFO Altimeter Engineering Assessment Report (document NASA/TM-2004209984/VER.1/VOL.6) noted (in its Section 2.2.7) that the GFO sigma0 had an uncorrected small temperature dependence of about ±0.2 dB. Figure 2-10 of that Assessment Report plotted GFO sigma0 cycle averages vs. receiver temperature (Trcvr) cycle averages, and by simply drawing an eyeball-estimated straight pencil line through the Figure 2-10 data, I estimated the slope D(sigma0)/D(Trcvr) to be about 0.033 dB per degree C.

Can we learn anything more about sigma0 trends with temperature by assessing GFO data in more detail than cycle averages? That's what I tried to do in this work, but the end result was no significant improvement over the 0.033 dB per degree C value given above. The details of the work are given in the following section.

Details

For this work we assumed that in some average sense there is a (nonlinear) relationship between an altimeter's SWH and sigma0 estimates, with higher sigma0 values being associated with lower SWH values. Under this assumption we should then be able to select sigma0 and Trcvr values at some one specific SWH value and look at the sigma0 vs. Trcvr trends. This process could then be repeated for several different SWH values, and we might then have a "finer grained" look at the sigma0 to Trcvr relationship than is available from cycle-averages only.

The data source for this work was the Wallops GFO over-ocean database and, after careful editing to remove effects such as sigma0 blooms from the data, Annette Conger provided me with about 1/3 of a year's 1-minute averages of these GFO quantities: time; windspeed estimate; receiver temperature (Trcvr); sigma0 estimate; and SWH estimate. Figure B-1 shows the history of GFO cycle-averaged Trcvr vs. cycle for almost 80 cycles, and Figure B-2 shows the 1-minute Trcvr averages for the 1/3 year of data that were analyzed for this report. For GFO's 17-day cycle, this 128 day data segment is about 7.5 GFO cycles, very roughly 1/10 of the total GFO data history in Figure B-1. Only the Trcvr, sigma0, and SWH point triples were used in this work.

I sorted the data into specific bins in Trcvr, sigma0, and SWH. A data histogram of Trcvr values is provided in Figure B-3; Figure B-4 shows the sigma0 histogram; and

Figure B-5 shows the SWH histogram. Based on Figure B-3 and Figure B-5, I chose widths of 0.50 degrees C for the Trcvr bins, and 0.10 meters for the SWH bins. It's not necessary to choose a sigma0 bin width, as one sigma0 average will be calculated for each pair of Trcvr and SWH bin center values.

Figure B-6 shows bin-averaged sigma0 vs. SWH bin center value for the two different Trcvr bins at 32.25 and 41.25 degrees C, and this figure does show a higher sigma0 estimate at the higher of the two temperature values. What we really want, however, is to select one SWH bin and assess the sigma0 vs. Trcvr behavior for that SWH, and then repeat this for different SWH bins. To look just at the differential sigma0 behavior with temperature, I formed an average sigma0 vs. SWH curve for all the data in the study set, and subtracted that average from the individual curves such as those in Figure B-6. Figure B-7 shows the individual data pairs in the average sigma0 vs. SWH curve together with low-order fitted polynomial curves. Dealing with data sorted into specific Trcvr and SWH bins requires deciding whether the sigma0 averages should be weighted by the bin numbers or not, and both possibilities were used in the data of Figure B-7. The sigma0 averages, not the polynomial fits, were used in the next figure, and the polynomial fits of Figure B-7 were provided only to show how relatively well-behaved the average sigma0 vs. SWH curves were.

Figure B-8 plots the sigma0 differences vs. Trcvr for four different SWH bin values. This analysis was started with the hope that for one SWH bin value, there would be a relatively well behaved curve of sigma0 differences vs. Trcvr, and that similar curves from different Trcvr values would be more or less identical. There is a small trend visible in each of the curves in Figure B-8 with each curve slightly lower on the left side of the figure and higher on the right, but the individual curves are really too noisy to make much of.

About the only thing to do was combine all the individual SWH bin data and produce a single curve (effectively the average of the four individual curves in Figure 8 plus all the additional ones from other SWH bin values). This combined sigma0 difference vs.Trcvr is shown in Figure B-9. Actually two different curves are shown in Figure B-9 because there's again the question of whether to form a result by straight bin averaging or by bin number weighted averaging. A linear fit to these results yields a final D(sigma0)/D(Trcvr) estimate of 0.030 dB per degree C for equally weighted bin averaging and 0.036 dB per degree C for the bin number weighted averaging. These values are both close to the 0.033 dB per degree C estimate that I made by simply drawing a straight pencil line on the plot of sigma0 cycle averages vs. Trcvr cycle averages (and that pencil line estimate had been made before I started any of this more intensive GFO data analysis).

Sometimes the answer to a noisy result is simply to analyze more data but that is unattractive for this problem. The results given here were based on analysis of about 1/10 of the entire available GFO data; cranking the full data set through this sort of analysis would beat down the error by just over a factor of three (i.e., the square root of 10) at most.

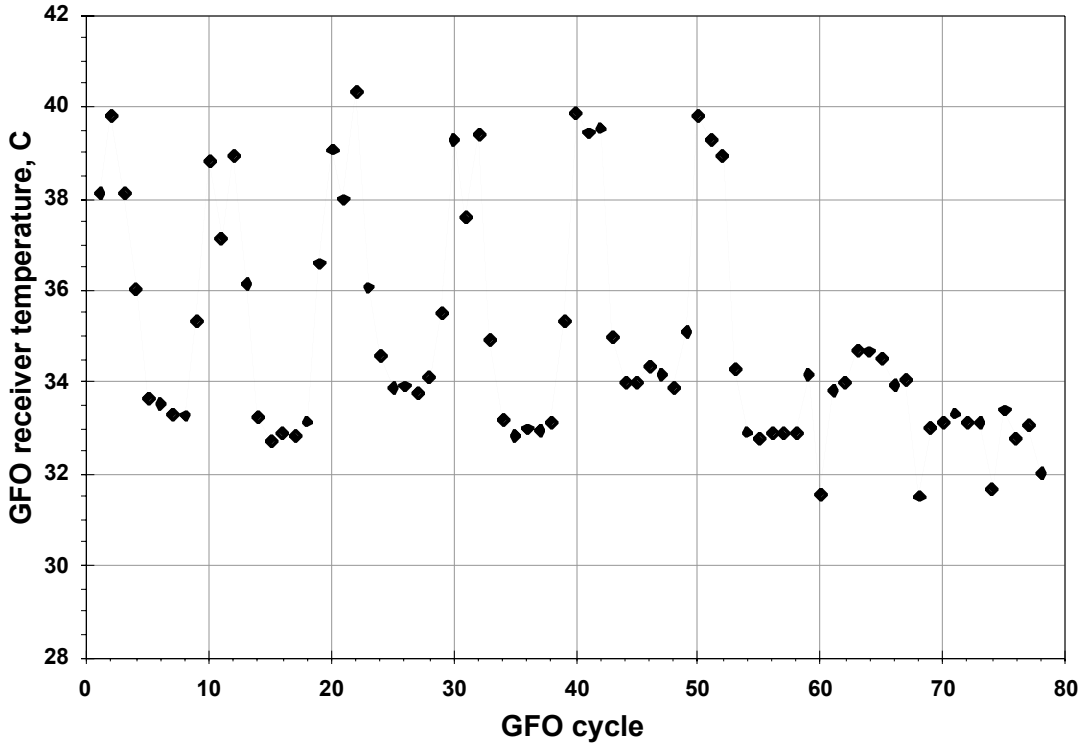

Figure B-1 GFO Cycle-Average Receiver Temperature vs. Cycle

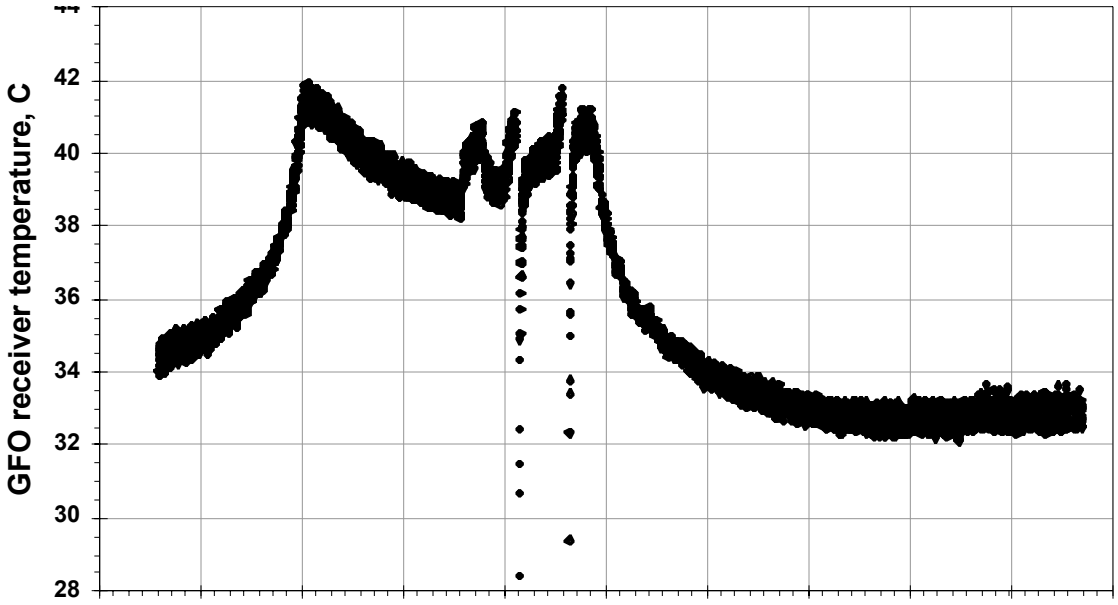

Figure B-2 GFO Receiver Temperature vs. Time (2003 days 057 through 184)

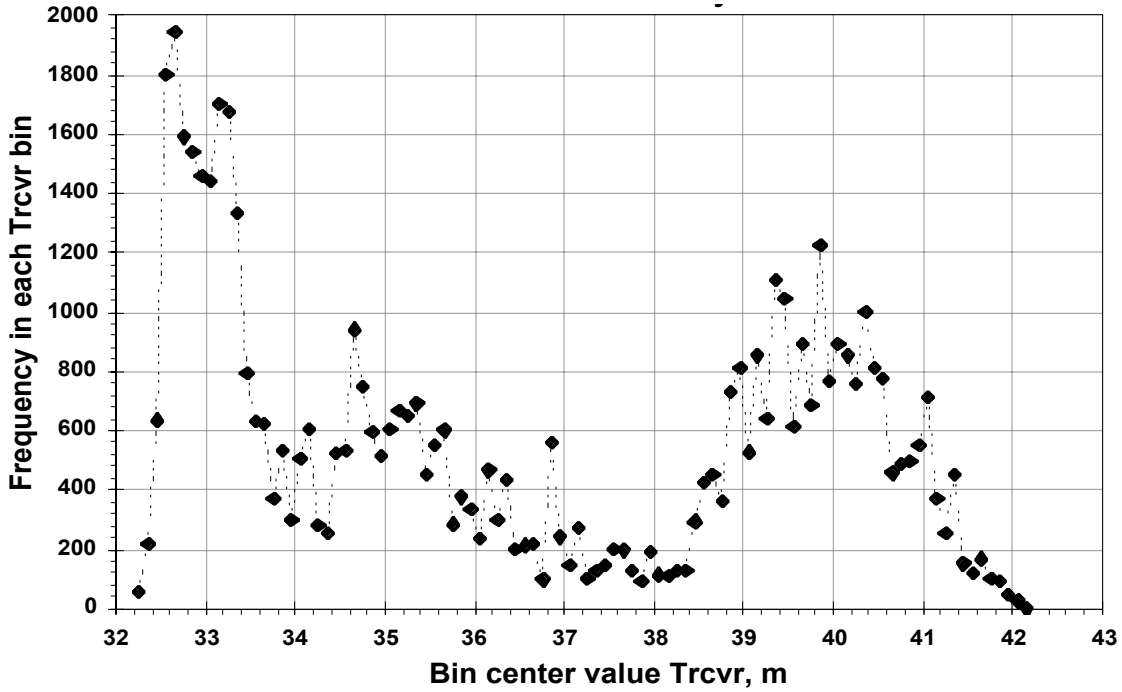

Figure B-3 GFO Receiver Temperature Histogram (edited database data from 2003 days 057 to 184)

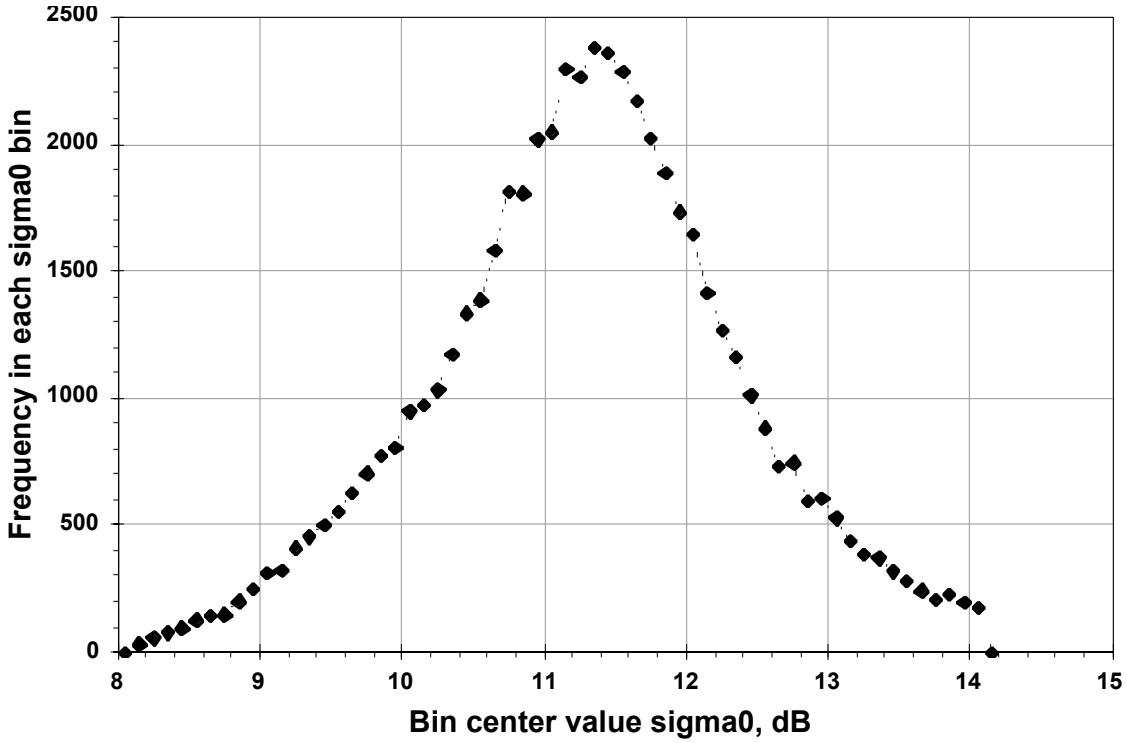

Figure B-4 GFO Sigma0 Histogram (edited database data from 2003 days 057 to 184)

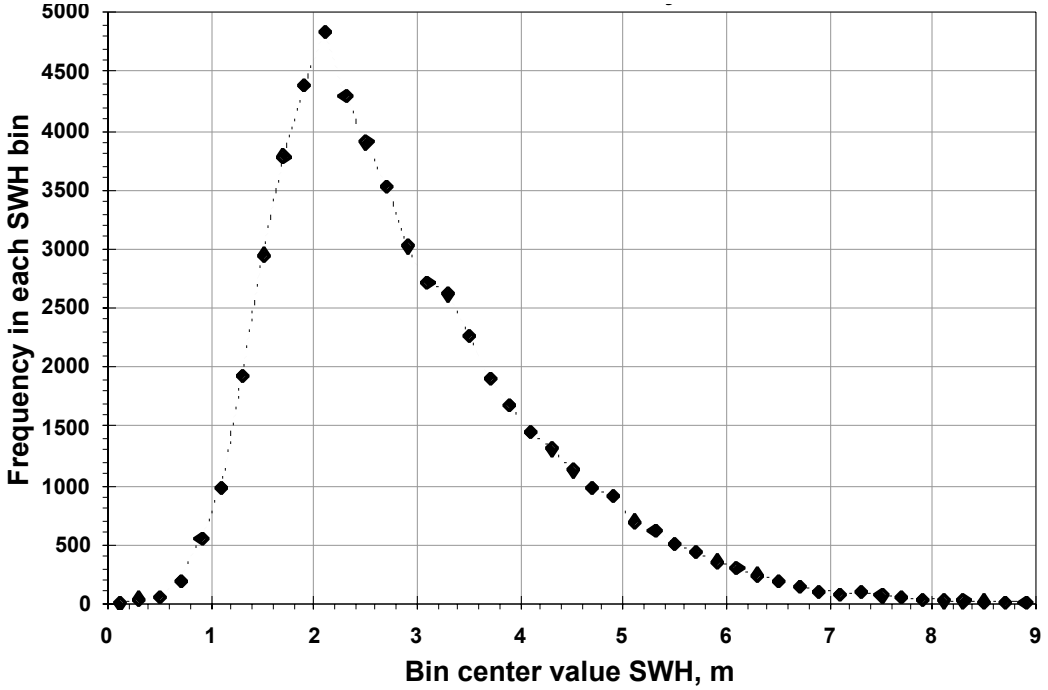

Figure B-5 GFO SWH Histogram (edited database data from 2003 days 057 to 184)

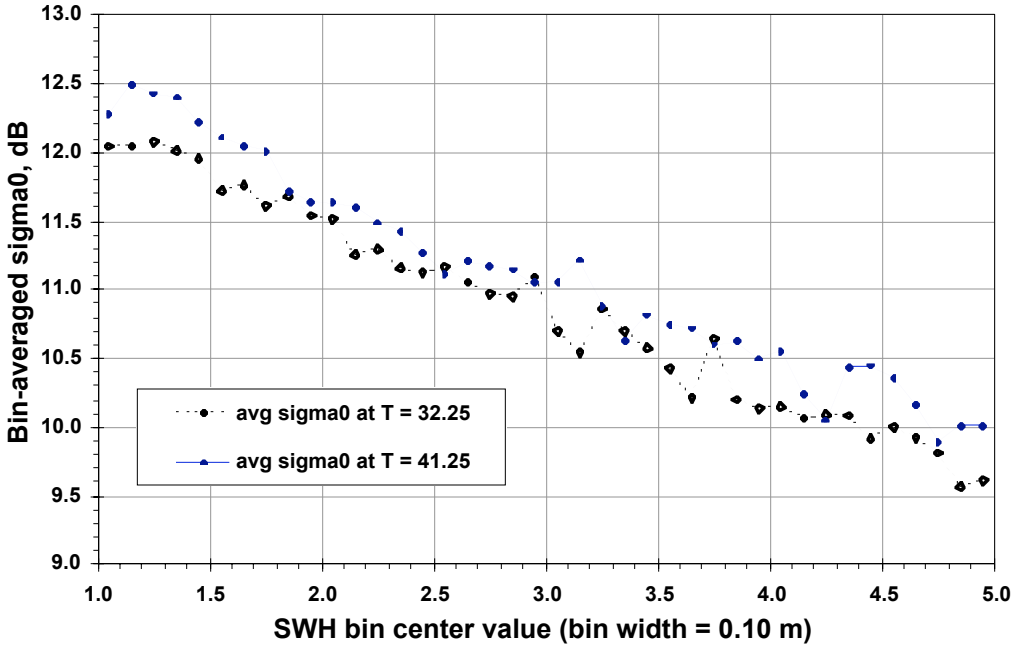

Figure B-6 GFO Bin-Averaged Sigma0 vs. Bin-Averaged SWH (for two different temperature bins, 2003 days 057 through 184)

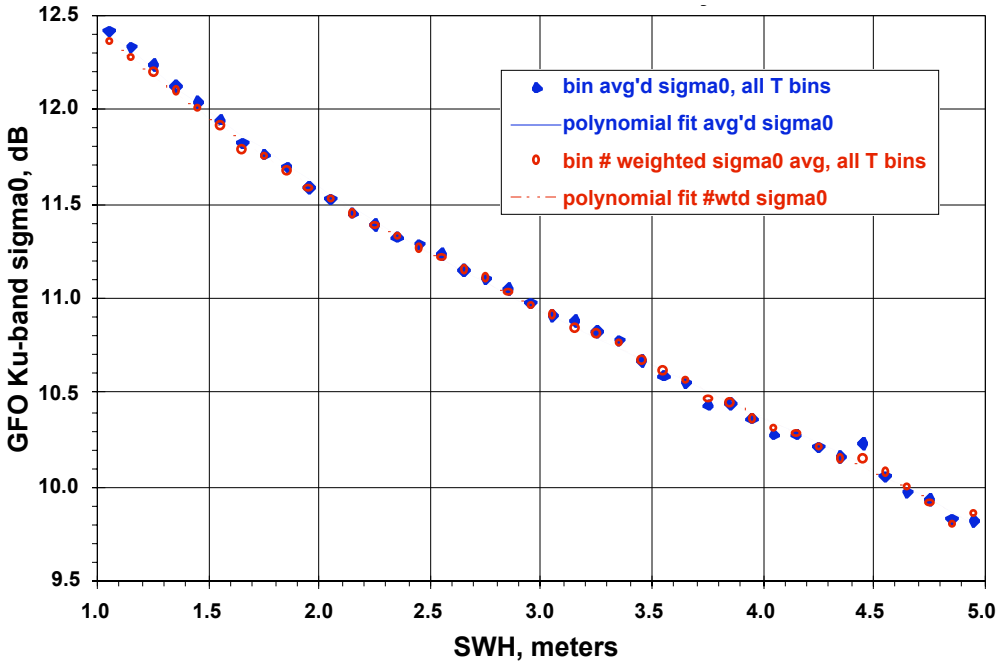

Figure B-7 GFO Sigma0 vs. SWH
(for edited WFF NGDR database data 2003 days 057 to 184)

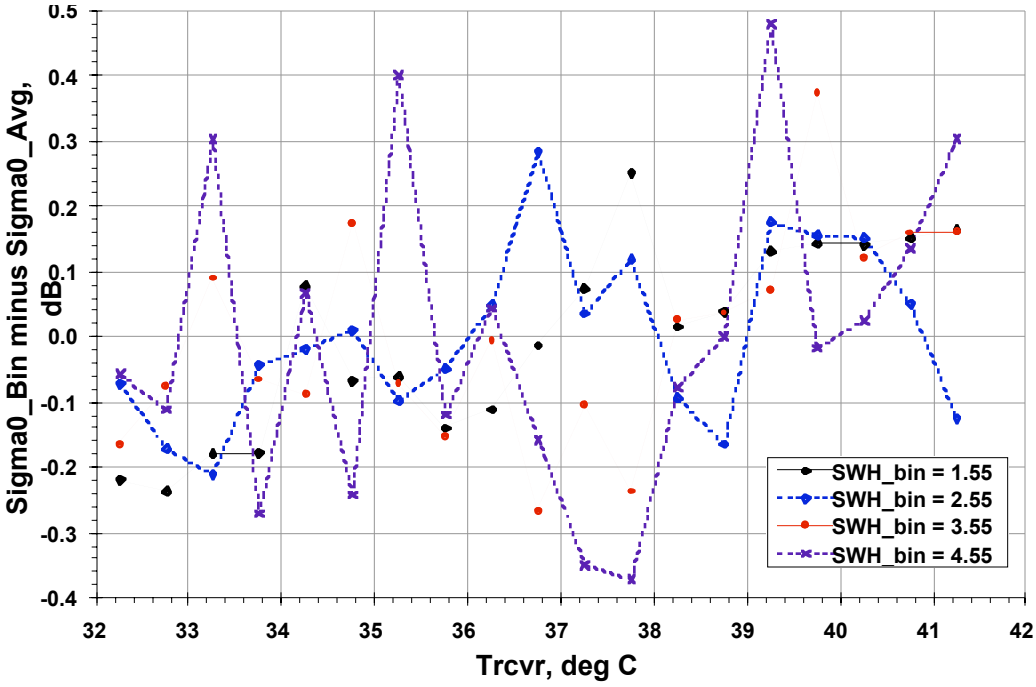

Figure B-8 Difference (Sigma0 - Sigma0 avg) vs. Trcvr
(for edited WFF NGDR database data 2003 days 057 to 184)

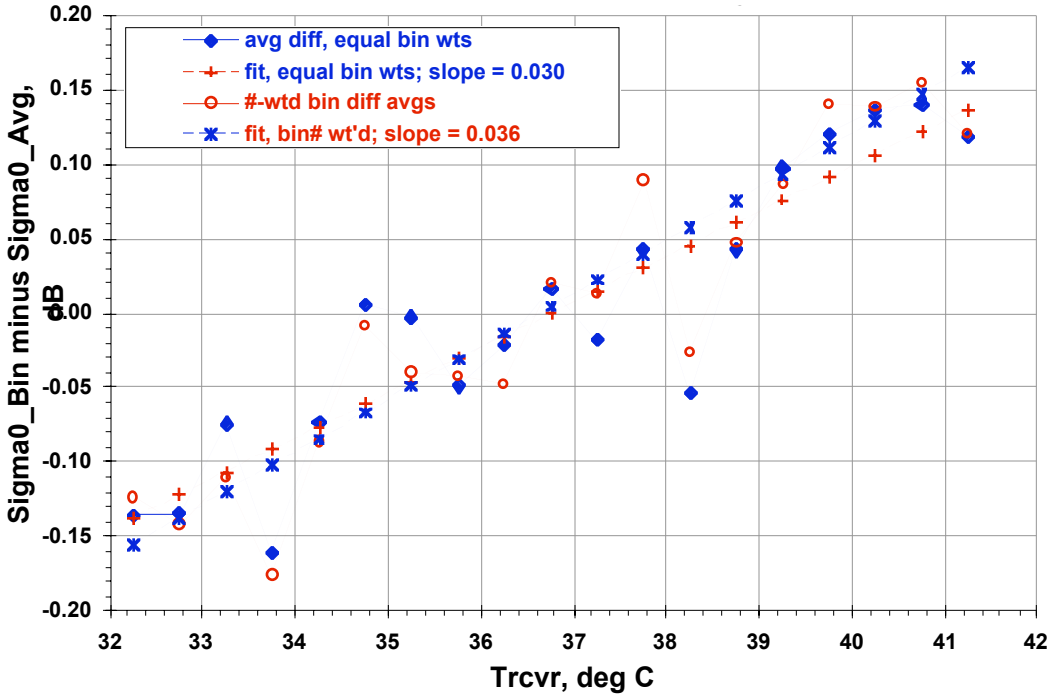

Figure B-9 Difference (Sigma0 - Sigma0 avg) vs. Trcvr (for edited WFF NGDR database data 2003 days 057 to 184)

Appendix C
GFO Key Events Log (Prior to December 9, 2003)

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Acceptance	29 Nov 2000 2000334T00:00:00Z	GFO Acceptance. SPAWAR authorizes DD250s.
Trim Burn	04 Dec 2000 2000339T06:55:00Z	ERO Trim Burn. 33.8 mm/sec at 0 deg yaw. Purpose is to raise the SMA and maintain the ERO.
Commanded	06 Dec 2000 2000341T13:34:00Z	A ground system planning error resulted in data outage of about 10.5 hours. The last command in the sequence, for an RA Calibration via CSM was omitted. This command normally sends the RA back to the Track mode. Since this last command was not sent, the RA was left in Standby mode until the next Calibration sequence was executed. Returned to track 06 Dec 2000, 2000341T23:59:00Z.
Moon Intrusion	07 Dec 2000 2000342T11:46:25Z	Moon Intrusion affected GFO pointing. Intrusion resulted in the nadir error exceeding acceptable limits (.27 degrees).
Moon Intrusion	07 Dec 2000 2000342T13:27:10Z	Moon Intrusion affected GFO pointing. Intrusion resulted in the nadir error exceeding acceptable limits (.27 degrees).
Moon Intrusion	07 Dec 2000 2000342T15:07:40Z	Moon Intrusion affected GFO pointing. Intrusion resulted in the nadir error exceeding acceptable limits (.27 degrees).
Trim Burn	08 Dec 2000 2000343T02:19:00Z	ERO Trim Burn. 6.9 mm/sec at 180 deg yaw (-6.9 mm/s). Purpose is to lower the SMA and keep the ground track from exceeding the western limit of the ERO.
Moon Intrusion	14 Dec 2000 2000349T12:48:53Z	Moon Intrusion affected GFO pointing.
Moon Intrusion	14 Dec 2000 2000349T14:48:34Z	Moon Intrusion affected GFO pointing.
Trim Burn	28 Dec 2000 2000363T12:53:00Z	ERO Trim Burn. 27.011 mm/sec at 0 deg yaw. Purpose is to raise the SMA and keep the ground track from exceeding the eastern limit of the ERO.
Moon Intrusion	14 Jan 2001 2001014T05:06:00Z	The maximum pointing error (ADNADER) was 0.55 degrees.Other intrusions at around this time may have occurred. None exceeded 0.27 degrees.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Commanded	19 Jan 2001 2001019T18:02:00Z	The attitude changed from above.25 to below.20 degrees and the Receiver Temperature started to increase from 35 degrees. Explanation: Navsoc started the battery reconditioning sequence. Among other things, this sequence turns on the second horizon scanner, which would explain the improved pointing. In addition to the horizon scanner, a GPS Receiver and the catbed heaters are also turned on - this would explain the increase in Temperatures. Battery deep discharge reconditioning was initiated on Jan 19 at 18:02z.
Behavior	20 Jan 2001 2001020T15:28:00Z	"Anomalous behavior in GFO reaction wheel 3 torques". Wheel torque for wheel 3 displaying unusually large swings in the applied wheel torque. Does not appear to be affecting the satellite pointing.
Variations	21 Jan 2001 2001021T00:00:00Z	Doppler problem (noise/degraded orbits). The Doppler Beacon Signal is rather noisy.
Commanded	24 Jan 2001 2001024T03:13:00Z	"GFO reaction wheel 3". Commanded spacecraft to run with horizon scanner 2 instead of the 2 horizon scanner configuration. During the horizon scanner switch there were transient nadir pointing errors in the order of 0.58 degrees. The attitude returned back to above.25 from below.20 degrees at this time. The Receiver Temperature did not change.
Power Cycled	24 Jan 2001 2001024T23:57:42Z	Reaction wheel 3 was power cycled. No change was seen in the satellites behavior.
Commanded	25 Jan 2001 2001025T18:10:00Z	Extra Loads used for battery deep discharge conditioning were shed. This should return the satellite to normal power and thermal balance. The satellite is being kept in the 1 failed cell configuration at VT 7.5.
Variations	26 Jan 2001 2001026T00:00:00Z	Doppler problem (noise/degraded orbits). The Doppler Beacon Signal noise has subsided and tracks are good/improving. The oscillator on beacon 1 can not handle increased temperature adequately.
Commanded	26 Jan 2001 2001026T17:39:54Z	Switched to the redundant wheel (wheel 4) and disabled wheel 3. This involves putting the satellite into acquire sun and the radar altimeter in stand-by. Running on redundant wheel, in point state and the radar altimeter back in track.
Maneuver	30 Jan 2001 2001030T01:47:00Z	The magnitude will be 29.4 mm/s and the yaw will be 0 degrees. GFO has drifted out of the ERO and is currently about 1.3 km east of the centerline (300 m out of limits). After the maneuver, GFO should drift back into the ERO by 1/31 at 16:15Z. Satellite had drifted 300 m out of ERO.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	05 Feb 2001 2001036T12:31:35Z	GFO horizon scanner has experienced a moon intrusion event which has caused excursions from acceptable nadir pointing limits (.27 degrees). The time of this excursion and maximum amplitude is: 12:31:35 - 12:31:45Z (0.40 degrees max)
Moon Intrusion	05 Feb 2001 2001036T14:12:00Z	The time of this excursion and maximum amplitude is: 14:12:00 - 14:12:30Z (0.95 degrees max)
Moon Intrusion	05 Feb 2001 2001036T15:52:50Z	The time of this excursion and maximum amplitude is: 15:52:50 - 15:53:10Z (0.47 degrees max)
Moon Intrusion	10 Feb 2001 2001041T06:30:00Z	The time of the excursion and maximum amplitude is: 06:30:00 - 06:30:15Z (0.43 degrees max)
Moon Intrusion	10 Feb 2001 2001041T08:10:50Z	The time of the excursion and maximum amplitude is: 08:10:50 - 08:11:20Z (0.86 degrees max)
Moon Intrusion	10 Feb 2001 2001041T09:51:45Z	The time of the excursion and maximum amplitude is: 09:51:45 - 09:52:10Z (0.87 degrees max)
Moon Intrusion	11 Feb 2001 2001042T04:32:25Z	The time of the excursion and maximum amplitude is: 04:32:25 - 04:32:40Z (0.35 degrees max)
Moon Intrusion	11 Feb 2001 2001042T13:47:05Z	The time of the excursion and maximum amplitude is: 13:47:05 - 13:47:10Z (0.60 degrees max)
Under Voltage	12 Feb 2001 2001043T21:57:00Z	GFO apparently suffered an under-voltage (UV1) event. As a consequence, the payload bus was powered off. Due to the load shedding effect of the UV1, GFO is in a safe power configuration. The payloads are off and GFO is not collecting data.
Payloads On	15 Feb 2001 2001045T06:49:00Z	Payloads turned back on. GFO in standby mode.
In Operation	16 Feb 2001 2001047T19:00:00Z	GFO collecting data, payloads switched from standby mode to track mode. The reconditioning reset, the battery voltages, temperatures and pressures appeared normal. The payloads were turned back on, software patches installed and then set to track and produce data over the weekend to test the batteries under load. Examination of the battery and other satellite data yesterday and today indicates that the bus voltages is about 27.8 (28 volt bus), the NiH battery temperatures are in the normal range of 8 to 9 deg C, and the pressures are running between 495 and 620 psi as they should. The system will be left in this condition (VT is 6.0) and closely monitored.
Trim Maneuver	01 Mar 2001 2001060T23:06:00Z	The purpose of the maneuver will be to raise the semi-major axis and maintain the ERO. The burn magnitude will be 28.719 mm/sec with a zero degree yaw offset.
Moon Intrusion	06 Mar 2001 2001065T00:54:00Z	The time of the excursion and maximum amplitude is: 00:54:00Z - 00:54:20Z (0.34 degrees max)

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	06 Mar 2001 2001065T02:34:10Z	The time of the excursion and maximum amplitude is: 02:34:10Z - 02:34:40Z (0.39 degrees max)
Moon Intrusion	06 Mar 2001 2001065T04:14:35Z	The time of the excursion and maximum amplitude is: 04:14:35Z - 04:15:10Z (0.48 degrees max)
Moon Intrusion	06 Mar 2001 2001065T05:54:55Z	The time of the excursion and maximum amplitude is: 05:54:55Z - 05:55:05Z (0.40 degrees max)
Moon Intrusion	06 Mar 2001 2001065T19:52:45Z	The time of the excursion and maximum amplitude is: 19:52:45Z - 19:53:15Z (0.63 degrees max)
Moon Intrusion	12 Mar 2001 2001071T04:12:30Z	The time of the excursion and maximum amplitude is: 04:12:30Z - 04:12:45Z (0.49 degrees max)
Moon Intrusion	12 Mar 2001 2001071T05:52:35Z	The time of the excursion and maximum amplitude is: 05:52:35Z - 05:53:10Z (0.67 degrees max)
Moon Intrusion	12 Mar 2001 2001071T07:33:05Z	The time of the excursion and maximum amplitude is: 07:33:05Z - 07:33:40Z (0.86 degrees max)
Moon Intrusion	12 Mar 2001 2001071T09:13:40Z	The time of the excursion and maximum amplitude is: 09:13:40Z - 09:14:05Z (0.74 degrees max)
Moon Intrusion	12 Mar 2001 2001071T18:10:20Z	The time of the excursion and maximum amplitude is: 18:10:20Z - 18:10:40Z (0.41 degrees max)
Moon Intrusion	12 Mar 2001 2001071T19:50:43Z	The time of the excursion and maximum amplitude is: 19:50:43Z - 19:51:10Z (0.59 degrees max)
Test Support	14 Mar 2001 2001073T21:48:30Z	Due to a Momentum Wheel 3 Testing support, the satellite yaw was about 0.47 degrees. GFO experienced pointing errors that exceeded the.27 degrees limit. The time of the excursion is: 21:48:30Z - 21:53:00Z
Trim Maneuver	21 Mar 2001 2001080T00:55:00Z	The burn magnitude will be 30.4 mm/sec with a zero degree yaw offset.
Trim Maneuver	30 Mar 2001 2001089T01:13:00Z	The burn magnitude will be 36 mm/sec with a zero degree yaw offset.
Trim Maneuver	03 Apr 2001 2001093T00:51:00Z	The next burn will be in 100 minutes.
Trim Maneuver	03 Apr 2001 2001093T02:31:00Z	The total burn magnitude will be 70 mm/sec with a zero degree yaw offset.
Trim Maneuver	04 Apr 2001 2001094T03:22:00Z	The burn magnitude will be 40 mm/sec with a 180 degree yaw offset.
Moon Intrusion	10 Apr 2001 2001100T19:53:33Z	The time of the excursion and maximum amplitude is: 19:53:33Z - 19:53:45Z (0.33 degrees max)

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	10 Apr 2001 2001100T21:33:50Z	The time of the excursion and maximum amplitude is: 21:33:50Z - 21:34:40Z (0.59 degrees max)
Moon Intrusion	10 Apr 2001 2001100T22:38:13Z	The time of the excursion and maximum amplitude is: 22:38:13Z - 22:38:48Z (0.40 degrees max)
Moon Intrusion	10 Apr 2001 2001100T23:14:35Z	The time of the excursion and maximum amplitude is: 23:14:35Z - 23:15:03Z (0.72 degrees max)
Moon Intrusion	11 Apr 2001 2001101T00:18:45Z	The time of the excursion and maximum amplitude is: 00:18:45Z - 00:19:20Z (0.68 degrees max)
Moon Intrusion	11 Apr 2001 2001101T00:55:02Z	The time of the excursion and maximum amplitude is: 00:55:02Z - 00:55:07Z (0.31 degrees max)
Moon Intrusion	11 Apr 2001 2001101T01:59:20Z	The time of the excursion and maximum amplitude is: 01:59:20Z - 01:59:47Z (0.74 degrees max)
Trim Maneuver	13 Apr 2001 2001103T00:30:00Z	The burn magnitude will be 30 mm/sec with a 0 degree yaw offset.
CSM Upload	30 Apr 2001 2001120T00:00:00Z	CSM Time Tag Anomaly. A CSM upload was planned on Wednesday (Day 115) to be uploaded on Friday (Day 117) with commands for Monday and Tuesday (Days 120 and 121). The times in the ASCII CSM.dat file are correct. The ground system uses the SCC on the ground system at HQ to convert the times to VTCW when building the CSM command. All of the commands in that CSM were 3 days 3 hours and 40 minutes earlier than they should have been. The commands for Day 121 executed on Day 118. The commands for Day 120 were changed to Day 116 which was in the past, so GFO interpreted that as 6 days and 8.7 hours in the future from Day 116 or Day 123-124. (CSM commands can be uploaded a maximum of 6 days 8.7 hours before they execute.)
Trim Maneuver	02 May 2001 2001122T05:39:00Z	The burn magnitude will be 30.9 mm/sec with a 0 degree yaw offset. GFO out of point: 122T05:32:00Z - 122T05:44:00Z.
Trim Maneuver	08 May 2001 2001128T05:05:00Z	The purpose of the maneuver will be a small “stopping” maneuver. The burn magnitude will be 4.4 mm/sec with a 180 degree yaw offset. GFO out of point: 128T04:58:00Z - 128T05:10:00Z.
Trim Maneuver	31 May 2001 2001151T23:49:00Z	The burn magnitude will be 16.8 mm/sec with a 0 degree yaw offset. GFO out of point: 151T23:42:00Z - 151T23:54:00Z
Reconditioning	04 Jun 2001 2001155T00:00:00Z	Battery reconditioning. This will continue until 14 June. Expected to have no affect on normal operations.
Moon Intrusion	11 Jun 2001 2001162T01:00:27Z	The time of the excursion and maximum amplitude is: 01:00:27Z - 01:00:29Z (0.31 degrees max)

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	11 Jun 2001 2001162T02:41:02Z	The time of the excursion and maximum amplitude is: 02:41:02Z - 02:41:25Z (0.63 degrees max)
Moon Intrusion	11 Jun 2001 2001162T04:21:42Z	The time of the excursion and maximum amplitude is: 04:21:42Z - 04:21:50Z (0.52 degrees max)
Antenna Swap	20 Jun 2001 2001171T00:00:00Z	The doppler system antenna at Headquarter has been swapped yesterday (6/20) afternoon (Pacific Time). As a result, the doppler system is out of degraded mode, and working nominally.
Antenna Swap	28 Jun 2001 2001179T00:00:00Z	The doppler system antenna at Headquarter is now back up and functioning again.
Trim Maneuver	29 Jun 2001 2001180T00:03:00Z	The burn magnitude will be 14.6 mm/sec with a 0 degree yaw offset. GFO out of point: 179T23:56:00Z - 180T00:08:00Z
Moon Intrusion	02 Jul 2001 2001183T02:48:53Z	The time of the excursion and maximum amplitude is: 02:48:53Z - 02:49:00Z (0.28 degrees max)
Moon Intrusion	02 Jul 2001 2001183T04:29:37Z	The time of the excursion and maximum amplitude is: 04:29:37Z - 04:29:42Z (0.29 degrees max)
Moon Intrusion	02 Jul 2001 2001183T17:29:02Z	The time of the excursion and maximum amplitude is: 17:19:02Z - 17:19:33Z (1.07 degrees max)
Moon Intrusion	02 Jul 2001 2001183T18:59:45Z	The time of the excursion and maximum amplitude is: 18:59:45Z - 19:00:15Z (0.92 degrees max)
Moon Intrusion	02 Jul 2001 2001183T20:40:23Z	The time of the excursion and maximum amplitude is: 20:40:23Z - 20:40:55Z (0.95 degrees max)
Moon Intrusion	02 Jul 2001 2001183T22:20:52Z	The time of the excursion and maximum amplitude is: 22:20:52Z - 22:20:58Z (0.34 degrees max)
Moon Intrusion	31 Jul 2001 2001212T07:55:22Z	The time of the excursion and maximum amplitude is: 07:55:22Z - 07:55:25Z (0.31 degrees max)
Moon Intrusion	01 Aug 2001 2001213T10:08:07Z	The time of the excursion and maximum amplitude is: 10:08:07Z - 10:08:30Z (0.94 degrees max)
Moon Intrusion	01 Aug 2001 2001213T11:48:34Z	The time of the excursion and maximum amplitude is: 11:48:34Z - 11:49:03Z (0.98 degrees max)
Moon Intrusion	01 Aug 2001 2001213T13:28:59Z	The time of the excursion and maximum amplitude is: 13:28:59Z - 13:29:36Z (0.51 degrees max)
Moon Intrusion	01 Aug 2001 2001213T15:09:59Z	The time of the excursion and maximum amplitude is: 15:09:59Z - 15:10:12Z (0.61 degrees max)
Moon Intrusion	07 Aug 2001 2001219T16:59:40Z	The time of the excursion and maximum amplitude is: 16:59:40Z - 16:59:55Z (0.28 degrees max)

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	07 Aug 2001 2001219T18:39:27Z	The time of the excursion and maximum amplitude is: 18:39:27Z - 18:39:48Z (0.90 degrees max)
Moon Intrusion	07 Aug 2001 2001219T20:20:17Z	The time of the excursion and maximum amplitude is: 20:20:17Z - 20:20:45Z (0.81 degrees max)
Moon Intrusion	07 Aug 2001 2001219T22:00:58Z	The time of the excursion and maximum amplitude is: 22:00:58Z - 22:01:03Z (0.29 degrees max)
Moon Intrusion	08 Aug 2001 2001220T23:28:25Z	The time of the excursion and maximum amplitude is: 23:28:25Z - 23:28:33Z (0.29 degrees max)
Trim Maneuver	14 Aug 2001 2001226T00:55:00Z	The burn magnitude will be 18.6 mm/sec with a 0 degree yaw offset. GFO out of point: 226T00:48:00Z - 226T01:00:00Z
Point Test	27 Aug 2001 2001239T17:05:40Z	GFO normally uses the vector method in point mode, but this method does not allow the use of the Target Table (Table 39) to generate offsets for the upcoming ABCAL maneuvers. The quaternion method does allow the use of the Target Table, but can be susceptible to coupling between Z-axis rotation and nadir pointing errors. A test was performed on GFO today (DOY 239) to determine the amount of coupling between Z-axis rotation and nadir errors while in quaternion point mode. GFO was placed in quaternion point mode for one rev (239/17:05:40 through 239/18:45:34) in order to collect the necessary data, then switched back into vector point mode.
Trim Maneuver	31 Aug 2001 2001243T00:27:00Z	The burn magnitude will be 23.6 mm/sec with a 0 degree yaw offset. GFO out of point: 243T00:20:00Z - 243T00:32:00Z
Moon Intrusion	07 Sep 2001 2001250T04:06:15Z	The time of the excursion and maximum amplitude is: 04:06:15Z - 04:06:40Z (0.39 degrees max)
Moon Intrusion	07 Sep 2001 2001250T05:46:45Z	The time of the excursion and maximum amplitude is: 05:46:45Z - 05:47:13Z (0.49 degrees max)
Moon Intrusion	07 Sep 2001 2001250T07:27:02Z	The time of the excursion and maximum amplitude is: 07:27:02Z - 07:27:35Z (0.46 degrees max)
Moon Intrusion	07 Sep 2001 2001250T09:07:34Z	The time of the excursion and maximum amplitude is: 09:07:34Z - 09:08:05Z (0.67 degrees max)
Moon Intrusion	07 Sep 2001 2001250T10:48:10Z	The time of the excursion and maximum amplitude is: 10:48:10Z - 10:48:35Z (0.68 degrees max)
Moon Intrusion	07 Sep 2001 2001250T12:28:45Z	The time of the excursion and maximum amplitude is: 12:28:45Z - 12:28:50Z (0.37 degrees max)
Trim Maneuver	15 Sep 2001 2001258T02:44:00Z	The burn magnitude will be 32.0 mm/sec with a 0 degree yaw offset. GFO out of point: 258T02:37:00Z - 258T02:49:00Z

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Trim Maneuver 1 of 2	28 Sep 2001 2001271T01:03:00Z	The total burn magnitude will be 48.8 mm/sec with a 0 degree yaw offset. GFO out of point: 271T00:56:00Z - 271T01:08:00Z
Trim Maneuver 2 of 2	28 Sep 2001 2001271T02:43:00Z	The total burn magnitude will be 48.8 mm/sec with a 0 degree yaw offset. GFO out of point: 271T02:36:00Z - 271T02:48:00Z
Moon Intrusion	05 Oct 2001 2001278T01:54:20Z	The time of the excursion and maximum amplitude is: 01:54:20Z - 01:55:10Z (0.83 degrees max)
Moon Intrusion	05 Oct 2001 2001278T03:35:05Z	The time of the excursion and maximum amplitude is: 03:35:05Z - 03:35:35Z (0.71 degrees max)
Moon Intrusion	06 Oct 2001 2001279T20:52:20Z	The time of the excursion and maximum amplitude is: 20:52:20Z - 20:52:30Z (0.30 degrees max)
Moon Intrusion	06 Oct 2001 2001279T22:32:25Z	The time of the excursion and maximum amplitude is: 22:32:25Z - 22:33:00Z (0.42 degrees max)
Moon Intrusion	07 Oct 2001 2001280T00:13:05Z	The time of the excursion and maximum amplitude is: 00:13:05Z - 00:13:25Z (0.34 degrees max)
Trim Maneuver 1 of 2	11 Oct 2001 2001284T02:46:00Z	The total burn magnitude will be 42.2 mm/sec with a 0 degree yaw offset. GFO out of point: 284T02:39:00Z - 284T02:51:00Z
Trim Maneuver 2 of 2	11 Oct 2001 2001284T04:26:00Z	The total burn magnitude will be 42.2 mm/sec with a 0 degree yaw offset. GFO out of point: 284T04:19:00Z - 284T04:31:00Z
Trim Maneuver 1 of 2	23 Oct 2001 2001296T03:29:00Z	The total burn magnitude will be 46.3 mm/sec with a 0 degree yaw offset. GFO out of point: 296T03:22:00Z - 296T03:34:00Z
Trim Maneuver 2 of 2	23 Oct 2001 2001296T05:09:00Z	The total burn magnitude will be 46.3 mm/sec with a 0 degree yaw offset. GFO out of point: 296T05:02:00Z - 296T05:14:00Z
Configuration	24 Oct 2001 2001297T18:46:50Z	As a result of the Wheel 3 patch activation and configuration change performed on GFO today, the satellite radar altimeter was out of track 1 mode between the following times: 297T18:46:50Z - 297T18:53:12Z. As a result, payload data will be affected accordingly. Also, the Satellite was out of point state during the following times: 297T18:47:02Z - 297T18:51:52Z.
Moon Intrusion	27 Oct 2001 2001300T21:16:00Z	The time of the excursion and maximum amplitude is: 21:16:00Z - 21:16:10Z (0.33 degrees max).
Moon Intrusion	27 Oct 2001 2001300T22:56:35Z	The time of the excursion and maximum amplitude is: 22:56:35Z - 22:56:40Z (0.30 degrees max).

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	28 Oct 2001 2001301T03:30:30Z	The time of the excursion and maximum amplitude is: 03:30:30Z - 03:30:40Z (0.33 degrees max).
Moon Intrusion	28 Oct 2001 2001301T05:11:00Z	The time of the excursion and maximum amplitude is: 05:11:00Z - 05:11:30Z (0.64 degrees max).
Moon Intrusion	28 Oct 2001 2001301T06:51:35Z	The time of the excursion and maximum amplitude is: 06:51:35Z - 06:51:50Z (0.67 degrees max).
Moon Intrusion	28 Oct 2001 2001301T08:32:10Z	The time of the excursion and maximum amplitude is: 08:32:10Z - 08:32:25Z (0.40 degrees max).
Trim Maneuver	01 Nov 2001 2001305T05:28:00Z	The burn magnitude will be 31.5 mm/sec with a 0 degree yaw offset. GFO out of point: 305T05:21:00Z - 305T05:33:00Z.
Moon Intrusion	04 Nov 2001 2001308T06:19:15Z	The time of the excursion and maximum amplitude is: 06:19:15Z - 06:19:45Z (0.65 degrees max).
Moon Intrusion	04 Nov 2001 2001308T07:59:50Z	The time of the excursion and maximum amplitude is: 07:59:50Z - 08:00:20Z (0.63 degrees max).
Moon Intrusion	04 Nov 2001 2001308T09:40:30Z	The time of the excursion and maximum amplitude is: 09:40:30Z - 09:40:35Z (0.33 degrees max).
Moon Intrusion	05 Nov 2001 2001309T05:17:10Z	The time of the excursion and maximum amplitude is: 05:17:10Z - 05:17:20Z (0.29 degrees max).
Moon Intrusion	05 Nov 2001 2001309T06:57:50Z	The time of the excursion and maximum amplitude is: 06:57:50Z - 06:58:00Z (0.35 degrees max).
ERO Violation	06 Nov 2001 2001310T01:45:00Z	Due to a decrease in drag, the GFO ground track is going to exceed the ERO (Tuesday 11/6) for about 6.5 days. The ERO is predicted to exceed 1000 m West on 11/6 at 01:45Z. The maximum excursion of 1227 m West will be on 11/9 at 06:54Z and the ground track will re-enter the ERO on 11/12 at 17:04Z.
Configuration	07 Nov 2001 2001311T19:51:34Z	On GFO rev Det A 19549 a switch of the reaction wheel configuration from 1-2-3 to 1-2-4.
Back in ERO	08 Nov 2001 2001312T21:00:00Z	GFO's ground track has turned around. The average ground track will be back inside the 1 km limit 312T21:00.
Trim Maneuver	15 Nov 2001 2001319T01:21:00Z	The burn magnitude will be 28.2 mm/sec with a 0 degree yaw offset. GFO out of point: 319T01:14:00Z - 305T01:27:00Z.
Moon Intrusion	26 Nov 2001 2001330T22:03:10Z	The time of the excursion and maximum amplitude is: 22:03:10Z - 22:03:45Z (0.67 degrees max).
Moon Intrusion	26 Nov 2001 2001330T23:43:50Z	The time of the excursion and maximum amplitude is: 23:43:50Z - 23:44:25Z (0.78 degrees max).
Moon Intrusion	27 Nov 2001 2001331T01:24:25Z	The time of the excursion and maximum amplitude is: 01:24:25Z - 01:24:40Z (0.54 degrees max).

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	28 Nov 2001 2001332T03:07:55Z	The time of the excursion and maximum amplitude is: 03:07:55Z - 03:08:05Z (0.41 degrees max).
Moon Intrusion	28 Nov 2001 2001332T04:48:35Z	The time of the excursion and maximum amplitude is: 04:48:35Z - 04:49:05Z (0.51 degrees max).
Moon Intrusion	28 Nov 2001 2001332T06:29:15Z	The time of the excursion and maximum amplitude is: 06:29:15Z - 06:29:25Z (0.31 degrees max).
Trim Maneuver	29 Nov 2001 2001333T00:40:00Z	The burn magnitude will be 26.5 mm/sec with a 0 degree yaw offset. GFO out of point: 305T00:33:00Z - 305T00:46:00Z.
Trim Maneuver	13 Dec 2001 2001347T01:22:00Z	The burn magnitude will be 25.7 mm/sec with a 0 degree yaw offset. GFO out of point: 305T01:15:00Z - 305T01:28:00Z.
ABCAL	20 Dec 2001 2001354T16:35:00Z	Performed ABCAL Maneuver: 354T16:35:00Z - 354T16:51:00Z. Each off-nadir excursion angle is 0.6 degrees in magnitude.
Trim Maneuver 1 of 2	26 Dec 2001 2001360T05:53:00Z	The total burn magnitude will be 39.0 mm/sec with a 0 degree yaw offset. GFO out of point: 360T05:46:00Z - 360T05:59:00Z.
Trim Maneuver 2 of 2	26 Dec 2001 2001360T07:34:00Z	The total burn magnitude will be 39.0 mm/sec with a 0 degree yaw offset. GFO out of point: 360T07:27:00Z - 360T07:40:00Z.
Moon Intrusion	27 Dec 2001 2001361T07:40:45Z	The time of the excursion and maximum amplitude is: 07:40:45Z - 07:41:30Z (0.35 degrees max).
Moon Intrusion	27 Dec 2001 2001361T09:21:50Z	The time of the excursion and maximum amplitude is: 09:21:50Z - 09:22:20Z (0.35 degrees max).
Moon Intrusion	27 Dec 2001 2001361T23:22:55Z	The time of the excursion and maximum amplitude is: 23:22:55Z - 23:23:15Z (0.33 degrees max).
Moon Intrusion	28 Dec 2001 2001362T01:03:35Z	The time of the excursion and maximum amplitude is: 01:03:35Z - 01:03:55Z (0.46 degrees max).
Trim Maneuver	03 Jan 2002 2002003T03:23:00Z	The burn magnitude will be 26.9 mm/sec with a 0 degree yaw offset. GFO out of point: 003T03:16:00Z - 003T03:29:00Z.
ERO Violation	03 Jan 2002 2002003T03:23:00Z	The GFO maneuver that executed on 1/3/02 03:23Z was designed to have the ground track turn around at 900 meters west. Post-maneuver analysis has shown that the maneuver was too large and will cause the ground track to drift to 1750 meters west before turning around. The ground track is predicted to exceed 1000 meters west on Sunday 1/6/02. A stopping maneuver will be planned and uploaded at 2002007T16:56Z to execute at 2002007T19:48Z.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Trim Maneuver	07 Jan 2002 2002007T19:44:00Z	The burn magnitude will be 8.0 mm/sec with a 180 degree yaw offset. GFO out of point: 007T19:37:00Z - 007T19:50:00Z. The ground track has stopped drifting west and is now drifting back into the ERO. The ground track should be within the 1000 meter limit on 1/12 around 17:11Z.
Trim Maneuver 1 of 2	16 Jan 2002 2002016T23:26:00Z	The total burn magnitude will be 37.87 mm/sec with a 0 degree yaw offset. GFO out of point: 016T23:19:00Z - 016T23:32:00Z.
Trim Maneuver 2 of 2	17 Jan 2002 2002017T01:06:00Z	The total burn magnitude will be 37.87 mm/sec with a 0 degree yaw offset. GFO out of point: 017T00:59:00Z - 017T01:12:00Z.
Moon Intrusion	26 Jan 2002 2002026T00:32:07Z	The time of the excursion and maximum amplitude is: 00:32:07Z - 00:32:35Z (0.80 degrees max).
Moon Intrusion	26 Jan 2002 2002026T02:12:55Z	The time of the excursion and maximum amplitude is: 02:12:55Z - 02:13:05Z (0.34 degrees max).
Moon Intrusion	26 Jan 2002 2002026T07:50:10Z	The time of the excursion and maximum amplitude is: 07:50:10Z - 07:50:30Z (0.35 degrees max).
Moon Intrusion	26 Jan 2002 2002026T09:30:50Z	The time of the excursion and maximum amplitude is: 09:30:50Z - 09:31:15Z (0.57 degrees max).
Moon Intrusion	26 Jan 2002 2002026T11:11:30Z	The time of the excursion and maximum amplitude is: 11:11:30Z - 11:11:38Z (0.37 degrees max).
Trim Maneuver 1 of 2	28 Jan 2002 2002028T02:08:00Z	The total burn magnitude will be 46.78 mm/sec with a 0 degree yaw offset. GFO out of point: 028T02:01:00Z - 028T02:14:00Z.
Trim Maneuver 2 of 2	28 Jan 2002 2002028T03:48:00Z	The total burn magnitude will be 46.78 mm/sec with a 0 degree yaw offset. GFO out of point: 028T03:41:00Z - 028T03:54:00Z.
Moon Intrusion	30 Jan 2002 2002030T23:30:20Z	The time of the excursion and maximum amplitude is: 23:30:20Z - 23:30:30Z (0.30 degrees max).
Trim Maneuver	31 Jan 2002 2002031T02:11:00Z	The burn magnitude will be 25.6 mm/sec with a 0 degree yaw offset. GFO out of point: 031T02:04:00Z - 031T02:17:00Z.
Moon Intrusion	31 Jan 2002 2002031T01:10:50Z	The time of the excursion and maximum amplitude is: 01:10:50Z - 01:11:00Z (0.34 degrees max).
Moon Intrusion	31 Jan 2002 2002031T02:50:55Z	The time of the excursion and maximum amplitude is: 02:50:55Z - 02:51:25Z (0.74 degrees max).
Moon Intrusion	31 Jan 2002 2002031T04:31:35Z	The time of the excursion and maximum amplitude is: 04:31:35Z - 04:32:00Z (0.77 degrees max).

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Trim Maneuver 1 of 2	13 Feb 2002 2002044T00:27:00Z	The total burn magnitude will be 56.2 mm/sec with a 0 degree yaw offset. GFO out of point: 044T00:21:00Z - 044T00:33:00Z.
Trim Maneuver 2 of 2	13 Feb 2002 2002044T02:07:00Z	The total burn magnitude will be 56.2 mm/sec with a 0 degree yaw offset. GFO out of point: 044T02:01:00Z - 044T02:13:00Z.
ERO Violation	19 Feb 2002 2002050T09:09:19Z	GFO will be out of the ERO for approximately two days from 2/19/02 09:09:19 to 2/21/02 14:49:21. The excursion should be no more than 50m West.
Moon Intrusion	23 Feb 2002 2002054T06:18:24Z	The time of the excursion and maximum amplitude is: 06:18:24Z - 06:18:26Z (0.28 degrees max).
Moon Intrusion	23 Feb 2002 2002054T07:59:05Z	The time of the excursion and maximum amplitude is: 07:59:05Z - 07:59:12Z (0.31 degrees max).
Moon Intrusion	24 Feb 2002 2002055T02:53:25Z	The time of the excursion and maximum amplitude is: 02:53:25Z - 02:53:31Z (0.36 degrees max).
Moon Intrusion	24 Feb 2002 2002055T04:33:55Z	The time of the excursion and maximum amplitude is: 04:33:55Z - 04:33:59Z (0.30 degrees max).
Trim Maneuver 1 of 2	27 Feb 2002 2002058T01:33:00Z	The total burn magnitude will be 50.1 mm/sec with a 0 degree yaw offset. GFO out of point: 058T01:26:00Z - 058T01:39:00Z.
Trim Maneuver 2 of 2	27 Feb 2002 2002058T03:13:00Z	The total burn magnitude will be 50.1 mm/sec with a 0 degree yaw offset. GFO out of point: 058T03:06:00Z - 058T031:19:00Z.
Moon Intrusion	01 Mar 2002 2002061T22:54:34Z	The time of the excursion and maximum amplitude is: 22:54:34Z - 22:54:43Z (0.40 degrees max).
Moon Intrusion	01 Mar 2002 2002061T23:30:27Z	The time of the excursion and maximum amplitude is: 23:30:27Z - 23:30:39Z (0.345 degrees max).
Moon Intrusion	02 Mar 2002 2002062T00:34:39Z	The time of the excursion and maximum amplitude is: 00:34:39Z - 00:35:11Z (0.55 degrees max).
Moon Intrusion	02 Mar 2002 2002062T01:10:38Z	The time of the excursion and maximum amplitude is: 01:10:38Z - 01:11:21Z (0.61 degrees max).
Moon Intrusion	02 Mar 2002 2002062T02:15:11Z	The time of the excursion and maximum amplitude is: 02:15:11Z - 02:15:38Z (0.725 degrees max).
ABCAL	05 Mar 2002 2002064T21:10:00Z	Performed ABCAL Maneuver: 064T21:10:00Z - 064T21:26:00Z. Each off-nadir excursion angle is 0.6 degrees in magnitude.
Trim Maneuver	07 Mar 2002 2002066T04:06:00Z	The burn magnitude will be 28.2 mm/sec with a 0 degree yaw offset. GFO out of point: 066T03:59:00Z - 066T04:12:00Z.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Trim Maneuver 1 of 2	19 Mar 2002 2002078T01:32:00Z	The total burn magnitude will be 47.0 mm/sec with a 0 degree yaw offset. GFO out of point: 078T01:25:00Z - 078T01:38:00Z.
Trim Maneuver 2 of 2	19 Mar 2002 2002078T03:12:00Z	The total burn magnitude will be 47.0 mm/sec with a 0 degree yaw offset. GFO out of point: 078T03:05:00Z - 078T03:18:00Z.
Moon Intrusion	26 Mar 2002 2002085T12:02:27Z	The time of the excursion and maximum amplitude is: 12:02:27Z - 12:02:35Z (0.723 degrees max).
Moon Intrusion	26 Mar 2002 2002085T12:02:37Z	The time of the excursion and maximum amplitude is: 12:02:37Z - 12:02:47Z (0.541 degrees max).
Moon Intrusion	26 Mar 2002 2002085T13:42:21Z	The time of the excursion and maximum amplitude is: 13:42:21Z - 13:42:27Z (0.348 degrees max).
Moon Intrusion	31 Mar 2002 2002090T07:52:31Z	The time of the excursion and maximum amplitude is: 07:52:31Z - 07:52:39Z (0.358 degrees max).
Moon Intrusion	31 Mar 2002 2002090T09:33:07Z	The time of the excursion and maximum amplitude is: 09:33:07Z - 09:33:17Z (0.793 degrees max).
Moon Intrusion	31 Mar 2002 2002090T09:33:25Z	The time of the excursion and maximum amplitude is: 09:33:25Z - 09:33:31Z (0.361 degrees max).
Moon Intrusion	31 Mar 2002 2002090T11:13:30Z	The time of the excursion and maximum amplitude is: 11:13:30Z - 11:13:36Z (0.380 degrees max).
Moon Intrusion	31 Mar 2002 2002090T15:39:46Z	The time of the excursion and maximum amplitude is: 15:39:46Z - 15:39:54Z (0.433 degrees max).
Moon Intrusion	31 Mar 2002 2002090T15:40:09Z	The time of the excursion and maximum amplitude is: 15:40:09Z - 15:40:17Z (0.407 degrees max).
Moon Intrusion	31 Mar 2002 2002090T17:20:15Z	The time of the excursion and maximum amplitude is: 17:20:15Z - 17:20:26Z (0.574 degrees max).
Moon Intrusion	31 Mar 2002 2002090T17:20:34Z	The time of the excursion and maximum amplitude is: 17:20:34Z - 17:20:46Z (0.460 degrees max).
Trim Maneuver 1 of 2	04 Apr 2002 2002094T03:20:00Z	The total burn magnitude will be 38.6 mm/sec with a 0 degree yaw offset. GFO out of point: 094T03:13:00Z - 094T03:26:00Z.
Trim Maneuver 2 of 2	04 Apr 2002 2002094T05:00:00Z	The total burn magnitude will be 38.6 mm/sec with a 0 degree yaw offset. GFO out of point: 094T04:53:00Z - 094T05:06:00Z.
ERO Violation	12 Apr 2002 2002102T13:57:00Z	(Exceeding ERO Limits) GFO's ground track is going to exceed the -1000m western limit and get to -1239m before turning around. A stopping maneuver will not be performed and the ground track will be allowed to drift back into the ERO limits on its own.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
ERO Violation	15 Apr 2002 2002105T00:00:00Z	Over the weekend the drag on GFO increased enough to keep its average ground track from violating the -1000m western ERO limit. The average ground track turned around on 4/13 at -904m. Between 4/12 and 4/15 there were 4 one revolution per day spikes that crossed the -1000m limit. The largest one went to -1033m.
Trim Maneuver	23 Apr 2002 2002113T01:33:00Z	The burn magnitude will be 33.3 mm/sec with a 0 degree yaw offset. GFO out of point: 113T01:26:00Z - 113T01:39:00Z.
Moon Intrusion	24 Apr 2002 2002114T10:40:35Z	The time of the excursion and maximum amplitude is: 10:40:35Z - 10:40:44Z (0.460 degrees max).
Moon Intrusion	24 Apr 2002 2002114T12:21:08Z	The time of the excursion and maximum amplitude is: 12:21:08Z - 12:21:18Z (0.380 degrees max).
Moon Intrusion	24 Apr 2002 2002114T14:01:27Z	The time of the excursion and maximum amplitude is: 14:01:27Z - 14:01:35Z (0.370 degrees max).
Moon Intrusion	30 Apr 2002 2002120T05:07:15Z	The time of the excursion and maximum amplitude is: 05:07:15Z - 05:07:19Z (0.340 degrees max).
Moon Intrusion	30 Apr 2002 2002120T06:47:43Z	The time of the excursion and maximum amplitude is: 06:47:43Z - 06:47:51Z (0.406 degrees max).
Moon Intrusion	30 Apr 2002 2002120T13:58:37Z	The time of the excursion and maximum amplitude is: 13:58:37Z - 13:58:39Z (0.278 degrees max).
Moon Intrusion	30 Apr 2002 2002120T13:58:55Z	The time of the excursion and maximum amplitude is: 13:58:55Z - 13:58:57Z (0.309 degrees max).
Moon Intrusion	30 Apr 2002 2002120T15:39:22Z	The time of the excursion and maximum amplitude is: 15:39:22Z - 15:39:33Z (0.596 degrees max).
Moon Intrusion	30 Apr 2002 2002120T15:39:41Z	The time of the excursion and maximum amplitude is: 15:39:41Z - 15:39:49Z (0.315 degrees max).
Moon Intrusion	30 Apr 2002 2002120T17:20:00Z	The time of the excursion and maximum amplitude is: 17:20:00Z - 17:20:06Z (0.446 degrees max).
Trim Maneuver	23 May 2002 2002143T00:53:00Z	The burn magnitude will be 20.4 mm/sec with a 0 degree yaw offset. GFO out of point: 143T00:46:00Z - 143T00:59:00Z.
Moon Intrusion	23 May 2002 2002143T13:00:36Z	The time of the excursion and maximum amplitude is: 13:00:36Z - 13:00:45Z (0.438 degrees max).
Moon Intrusion	23 May 2002 2002143T14:41:26Z	The time of the excursion and maximum amplitude is: 14:41:26Z - 14:41:30Z (0.371 degrees max).
Moon Intrusion	23 May 2002 2002143T14:41:45Z	The time of the excursion and maximum amplitude is: 14:41:45Z - 14:41:47Z (0.275 degrees max).
Moon Intrusion	23 May 2002 2002143T17:28:10Z	The time of the excursion and maximum amplitude is: 17:28:10Z - 17:28:21Z (0.908 degrees max).

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	23 May 2002 2002143T17:28:25Z	The time of the excursion and maximum amplitude is: 17:28:25Z - 17:28:35Z (0.581 degrees max).
Moon Intrusion	23 May 2002 2002143T19:08:52Z	The time of the excursion and maximum amplitude is: 19:08:52Z - 19:08:54Z (0.623 degrees max).
Moon Intrusion	23 May 2002 2002143T19:08:56Z	The time of the excursion and maximum amplitude is: 19:08:56Z - 19:09:06Z (0.619 degrees max).
Moon Intrusion	23 May 2002 2002143T19:09:08Z	The time of the excursion and maximum amplitude is: 19:09:08Z - 19:09:23Z (0.798 degrees max).
Moon Intrusion	23 May 2002 2002143T20:49:23Z	The time of the excursion and maximum amplitude is: 20:49:23Z - 20:49:34Z (0.744 degrees max).
Moon Intrusion	23 May 2002 2002143T20:49:50Z	The time of the excursion and maximum amplitude is: 20:49:50Z - 20:50:04Z (0.637 degrees max).
Moon Intrusion	23 May 2002 2002143T20:50:15Z	The time of the excursion and maximum amplitude is: 20:50:15Z - 20:50:17Z (0.277 degrees max).
Moon Intrusion	23 May 2002 2002143T22:30:41Z	The time of the excursion and maximum amplitude is: 22:30:41Z - 22:30:45Z (0.312 degrees max).
Trim Maneuver	13 Jun 2002 2002164T23:04:00Z	The burn magnitude will be 13.6 mm/sec with a 0 degree yaw offset. GFO out of point: 164T22:57:00Z - 164T23:10:00Z.
ABCAL	18 Jun 2002 2002169T03:30:00Z	Performed ABCAL Maneuver: 169T03:30:00Z - 169T03:46:00Z.
Moon Intrusion	08 Jul 2002 2002189T18:33:32Z	The time of the excursion and maximum amplitude is: 18:33:32Z - 18:38:32Z (0.291 degrees max).
Moon Intrusion	21 Jul 2002 2002202T15:26:09Z	The time of the excursion and maximum amplitude is: 15:26:09Z - 15:26:30Z (0.580 degrees max).
Moon Intrusion	21 Jul 2002 2002202T17:06:37Z	The time of the excursion and maximum amplitude is: 17:06:37Z - 17:07:02Z (0.650 degrees max).
Moon Intrusion	21 Jul 2002 2002202T18:47:00Z	The time of the excursion and maximum amplitude is: 18:47:00Z - 18:47:32Z (0.400 degrees max).
Moon Intrusion	21 Jul 2002 2002202T20:27:56Z	The time of the excursion and maximum amplitude is: 20:27:56Z - 20:28:03Z (0.350 degrees max).
Trim Maneuver	24 Jul 2002 2002205T19:48:00Z	The burn magnitude will be 20.3 mm/sec with a 0 degree yaw offset. GFO out of point: 205T19:41:00Z - 205T19:54:00Z.
Moon Intrusion	27 Jul 2002 2002208T04:21:45Z	The time of the excursion and maximum amplitude is: 04:21:45Z - 04:21:51Z (0.330 degrees max).
Moon Intrusion	27 Jul 2002 2002208T06:02:07Z	The time of the excursion and maximum amplitude is: 06:02:07Z - 06:02:17Z (0.440 degrees max).

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Trim Maneuver	08 Aug 2002 2002220T23:44:00Z	The burn magnitude will be 16.0 mm/sec with a 0 degree yaw offset. GFO out of point: 220T23:37:00Z - 220T23:50:00Z.
Trim Maneuver	22 Aug 2002 2002234T23:11:00Z	The burn magnitude will be 32.7 mm/sec with a 0 degree yaw offset. GFO out of point: 234T23:04:00Z - 234T23:17:00Z.
Moon Intrusion	25 Aug 2002 2002237T12:46:30Z	The terminology for moon intrusions has changed. Recent analysis of these events has shown that the angles being measured are only the horizon sensor outputs as a result of the moon intrusions. By the time the attitude control system analysis has begun to respond (start to spin up the momentum wheels) and with the satellite inertia to be overcome, any momentary moon intrusion has likely ended before anything more than a negligible spacecraft motion occurs.
Moon Intrusion	25 Aug 2002 2002237T14:26:53Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	27 Aug 2002 2002239T16:04:53Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	27 Aug 2002 2002239T17:45:27Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	27 Aug 2002 2002239T19:26:03Z	Momentary horizon sensor measurements errors have resulted.
ERO Violation	31 Aug 2002 2002243T17:42:00Z	(Exceeding ERO Limits) The current ground track prediction for GFO indicates that the satellite will violate the ERO between 1742Z on 8/31/02 and 2322Z on 9/2/02. It is predicted to only drift to a maximum of 25m west of the boundary. Historically, we have not performed stopping maneuvers for violations of such small magnitude.
Trim Maneuver	13 Sep 2002 2002256T00:00:00Z	The burn magnitude will be 35.2 mm/sec with a 0 degree yaw offset. GFO out of point: 255T23:53:00Z - 256T00:06:00Z.
Moon Intrusion	15 Sep 2002 2002258T17:28:52Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	15 Sep 2002 2002258T19:09:20Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	15 Sep 2002 2002258T20:49:47Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	24 Sep 2002 2002267T05:29:50Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	24 Sep 2002 2002267T07:10:13Z	Momentary horizon sensor measurements errors have resulted.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Trim Maneuver	02 Oct 2002 2002275T23:25:00Z	The burn magnitude will be 35.7 mm/sec with a 0 degree yaw offset. GFO out of point: 275T23:18:00Z - 275T23:31:00Z.
Anomaly	15 Oct 2002 2002288T00:00:00Z	An apparent satellite encryptor anomaly prevented the ground system from re-acquiring telemetry following the swap to transmitter 2 (omni) at the beginning of today's planned swap to wheel 2,3,4 configuration support. No further commanding was attempted until the following support. On the following support, XM2 was shut off and XM1 was powered on, resulting in the successful re-acquisition of telemetry.
Configuration	16 Oct 2002 2002289T21:13:35Z	The GFO reaction wheel configuration will be modified from wheels 1-2-4 to 2-3-4 during a support between 21:13:15z and 21:24:58z.
Moon Intrusion	17 Oct 2002 2002290T05:23:54Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	17 Oct 2002 2002290T07:04:27Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	17 Oct 2002 2002290T08:44:58Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	17 Oct 2002 2002290T10:25:38Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	17 Oct 2002 2002290T17:40:04Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	17 Oct 2002 2002290T19:20:39Z	Momentary horizon sensor measurements errors have resulted.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Wheel Alarms	18 Oct 2002 2002291T08:00:00Z	At about 291/0800z, during the first DSU dump (DC 24479) following the recent GPS 4 turn on, NAVSOC DSMs received incoming alarms indicating out-of-limit wheel 1 -15V values. The DSMs notified the GFO lead engineer of these alarms, which reported a value of around -17.55V. Prior to the GPS 4 turn on, this telemetry point had been around -15.5V. Upon arrival to NAVSOC, GFO engineers immediately began evaluating the latest available DSU data. This data confirmed their suspicion that the GFO wheel 1 $\pm$15V telemetry had begun a steady increase temporally concurrent with the turn on of GPS 4, which occurred at approximately 290/2050z. Ball Aerospace was contacted regarding this situation, and it was decided that on the next available support, (rev DA 24481 @ 291/1142z) GPS 4 should be immediately turned off, the CSM cleared (it still commands), and the in-progress Cal 3 terminated. In addition, Ball directed GFO engineers to perform the recently prepared wheel swap (to wheels 2-3-4) if they observe either wheel 1 +15V or -15V telemetry exceeding 19.0V in magnitude during this or any subsequent supports. The wheel 1 -15V telemetry point was around -18.3V on the first recovery support (DA 24481), so no wheel swap was performed. On the following two supports, GFO engineers continued to monitor wheel 1 $\pm$15V telemetry closely. DSU dumps were performed on both of these supports, and the data retrieved was immediately analyzed for wheel 1 $\pm$15V trending. The DSU data indicated that at approximately 291/1400z the wheel 1 +15V and -15V telemetry peaked in magnitude at 18.55V and 18.79V, respectively, before decreasing again. The most recent support (LP 24484 @ 291/1645z) showed the wheel 1 +15V and -15V down to 18.07V and 18.31V in magnitude, respectively. Ball has approved the prepared wheel swap planning products for implementation as soon as practical. This support has been planned for rev DC 24486 @ 291/2013z.
Configuration	18 Oct 2002 2002291T20:13:35Z	The GFO reaction wheel configuration will be modified from wheels 1-2-4 to 2-3-4 during a support between 21:13:15z and 21:24:58z.
Calibration	21 Oct 2002 2002294T00:00:00Z	TTCS/GPS calibration is going to be performed at Det C. The plan is to turn on the GPS receiver Thursday, and begin the calibration Friday.
Trim Maneuver	24 Oct 2002 2002297T00:05:00Z	The burn magnitude will be 26.1 mm/sec with a 0 degree yaw offset. GFO out of point: 296T23:58:00Z - 297T00:11:00Z.
ABCAL	13 Nov 2002 2002317T18:30:00Z	Performed ABCAL Maneuver: 317T18:30:00Z - 169T18:46:00Z.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Commanded	14 Nov 2002 2002318T00:00:00Z	Time Bias Correction. 15 microsecond change to bias.
Commanded	14 Nov 2002 2002318T00:00:00Z	Battery heater duty cycle is approximately 33%. Per battery management request the VT level was changed to 5.5 this afternoon.
Trim Maneuver	14 Nov 2002 2002318T23:55:00Z	The burn magnitude will be 22.1 mm/sec with a 0 degree yaw offset. GFO out of point: 318T23:48:00Z - 319T00:01:00Z.
Moon Intrusion	15 Nov 2002 2002319T22:16:04Z	Momentary horizon sensor measurements errors has been caused.
Moon Intrusion	15 Nov 2002 2002319T23:56:44Z	Momentary horizon sensor measurements errors has been caused.
Moon Intrusion	16 Nov 2002 2002320T01:37:18Z	Momentary horizon sensor measurements errors has been caused.
Moon Intrusion	16 Nov 2002 2002320T03:17:21Z	Momentary horizon sensor measurements errors has been caused.
Moon Intrusion	17 Nov 2002 2002321T06:44:21Z	Momentary horizon sensor measurements errors has been caused.
Moon Intrusion	17 Nov 2002 2002321T08:25:05Z	Momentary horizon sensor measurements errors has been caused.
Commanded	26 Nov 2002 2002330T00:00:00Z	The VT level was changed from 5.5 to 6.0 on Tuesday.
Reaction Wheel	27 Nov 2002 2002331T08:00:00Z	In discussions with Mike Weiss this morning he advised us that Ball had some very informative conversations with Inter-point - the mfgr of the wheel controller electronics. Although the good news is that this is a mfgr that is being very open and cooperative in discussions, the bad news is that we basically need to consider Wheel One LOST. After reviewing the events and confirming lot numbers of parts the conclusion is that the erratic behavior we saw earlier was a result of a radiation induced failure to an optical isolator/coupler and that based on prior experience/history this will only continue to get worse and possibly fry the electronics in that wheel. Current plan is to continue as is on wheels 2, 3, and 4 and to modify the onboard ROM so that wheel one does not inadvert-ently come on.
ERO Maneuver	11 Dec 2002 2002345T01:26:00Z	The burn magnitude will be 26.3 mm/sec with a 0 degree yaw offset. GFO out of point: 345T01:19:00Z - 345T01:32:00Z.
Moon Intrusion	16 Dec 2002 2002350T07:55:01Z	Momentary horizon sensor measurements errors have resulted.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	16 Dec 2002 2002350T09:35:33Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	16 Dec 2002 2002350T11:16:35Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	16 Dec 2002 2002350T12:57:13Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	17 Dec 2002 2002351T02:58:17Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	17 Dec 2002 2002351T04:39:02Z	Momentary horizon sensor measurements errors have resulted.
Trim Maneuver	27 Dec 2002 2002361T01:30:05Z	The burn magnitude will be 24.2 mm/sec with a 0 degree yaw offset. GFO out of point: 361T01:23:05Z - 361T01:36:05Z.
Moon Intrusion	14 Jan 2003 2003014T21:28:33Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	14 Jan 2003 2003014T23:08:55Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	15 Jan 2003 2003015T00:49:14Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	15 Jan 2003 2003015T02:29:40Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	15 Jan 2003 2003015T04:10:40Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	15 Jan 2003 2003015T18:08:45Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	20 Jan 2003 2003020T19:51:12Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	20 Jan 2003 2003020T21:31:21Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	20 Jan 2003 2003020T23:11:54Z	Momentary horizon sensor measurements errors have resulted.
ERO Maneuver	23 Jan 2003 2003023T02:32:00Z	The burn magnitude will be 28.2 mm/sec with a 0 degree yaw offset. GFO out of point: 023T02:25:00Z - 023T02:30:00Z.
ERO Maneuver	18 Feb 2003 2003049T02:28:00Z	The burn magnitude will be 27.6 mm/sec with a 0 degree yaw offset. GFO out of point: 049T02:21:00Z - 049T02:34:00Z.
Moon Intrusion	19 Feb 2003 2003050T14:51:35Z	Momentary horizon sensor measurements errors have resulted.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	19 Feb 2003 2003050T16:32:08Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	19 Feb 2003 2003050T18:12:27Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	19 Feb 2003 2003050T22:37:44Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	20 Feb 2003 2003051T00:17:46Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	20 Feb 2003 2003051T01:58:17Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	20 Feb 2003 2003051T03:38:48Z	Momentary horizon sensor measurements errors have resulted.
Wheel 1 Test	27 Feb 2003 2003058T21:50:00Z	A wheel 1 test was performed today, causing an expected but minimal increase in attitude error. The test occurred during a support between 058/2150z and 058/2200z, and the spacecraft was over land throughout the duration of the test. The spacecraft measured nadir error remained below 0.2 degrees throughout the test. As a reult of Wheel 1 test, the GFO DTU was out of Cal Mode between 21:48:37Z and 21:56:19Z.
ERO Violation	04 Mar 2003 2003063T00:13:00Z	(Exceeding ERO Limits) GFO exceeded the western 1 km ERO limit today (3/4) at 00:13Z. It is currently predicted to drift out to 1.2 km west before drifting back into the ERO on 3/13.
ABCAL	06 Mar 2003 2003065T23:30:00Z	Performed ABCAL Maneuver: 065T23:30:00Z - 065T23:46:00Z.
ERO Return	11 Mar 2003 2003070T04:58:00Z	GFO's ground track drifted back within the -1000 meter limit. The maximum excursion of the average ground track was 117 meters. The largest once per day spike in the ground track was 256 meters outside the limit.
Moon Intrusion	21 Mar 2003 2003080T00:51:35Z	Momentary horizon sensor measurements errors have resulted.
ERO Maneuver	21 Mar 2003 2003080T01:50:00Z	The burn magnitude will be 20.4 mm/sec with a 0 degree yaw offset. GFO out of point: 080T01:43:00Z - 080T01:56:00Z. The maneuver will cause a 13 minute data outage in RA full waveform data collection.
Moon Intrusion	21 Mar 2003 2003080T02:32:15Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	21 Mar 2003 2003080T04:12:33Z	Momentary horizon sensor measurements errors have resulted.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	13 Apr 2003 2003103T13:06:05Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	13 Apr 2003 2003103T14:46:42Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	13 Apr 2003 2003103T16:27:26Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	14 Apr 2003 2003104T06:59:48Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	14 Apr 2003 2003104T08:40:20Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	14 Apr 2003 2003104T10:20:56Z	Momentary horizon sensor measurements errors have resulted.
Battery Reconditioning	16 Apr 2003 2003106T13:10:00Z	Mort Rau consulted with the representative for the PEO for C4I and received authorization to proceed with the battery reconditioning evolution. This will involve having the RA payloads in standby and satellite in sun pointing mode from approximately 106T13:10Z Wednesday (April 16) as part of the deep discharge process. RA was placed back into track on Thursday (April 17) at 107T01:25Z with a resultant data gap.
Moon Intrusion	20 Apr 2003 2003110T09:53:22Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	20 Apr 2003 2003110T11:33:48Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	20 Apr 2003 2003110T23:40:56Z	Momentary horizon sensor measurements errors have resulted.
Commanded	21 Apr 2003 2003111T22:10:00Z	In preparation for a second GFO battery discharge, the VT level was raised from 5.5 to 6.0 and the catbed heaters were turned on. DDL will cease operations on Tuesday, April 22, around 112T10:10Z in preparation for the discharge.
Battery Reconditioning	22 Apr 2003 2003112T21:30:00Z	The RA payloads put in standby, the satellite put into Acquire Sun mode and the battery will be slowly discharged down to 25.6 volts from approximately 112T21:30Z. On Wednesday 4/23 around 113T14:30Z, the satellite will be put back to it's original configuration: Point state, RA in Track 1, catbed heaters off, and VT 5.5, with a resultant data gap.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
2nd Battery Discharged	23 Apr 2003 2003113T21:07:00Z	The support to put GFO back into point and the RA back into Track 1 mode at 14:30Z today failed because the ground station at Laguna Peak was not functioning. The next available support was at 21:07Z at Det C. During this support, GFO was put back into point, the RA was put back to Track 1 mode, and the power configuration was put back to normal including going to VT 5.5 and turning the catbed heaters off. Due to the LP ground station not functioning, CSM was uploaded to resume DDL mode and 10 minute RA calibrations on Thursday 4/23. The 7 hour full waveform RA data collection will be resumed when LP has demonstrated that it is functioning again.
ERO Maneuver	29 Apr 2003 2003119T01:58:00Z	The burn magnitude will be 17.1 mm/sec with a 0 degree yaw offset. GFO out of point: 119T01:51:00Z - 119T02:04:00Z. The maneuver will cause a 13 minute data outage in RA full waveform data collection.
ERO Maneuver	09 May 2003 2003129T01:52:00Z	The burn magnitude will be 5.4 mm/sec with a 180 degree yaw offset. GFO out of point: 129T01:45:00Z - 129T01:58:00Z.
Moon Intrusion	11 Jun 2003 2003162T17:51:10Z	Momentary horizon sensor measurements errors have resulted.
ERO Maneuver	12 Jun 2003 2003163T00:56:00Z	The burn magnitude will be 16.8 mm/sec with a 0 degree yaw offset. GFO out of point: 163T00:49:00Z - 163T01:02:00Z.
Moon Intrusion	12 Jun 2003 2003163T06:40:12Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	12 Jun 2003 2003163T08:20:50Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	12 Jun 2003 2003163T10:01:40Z	Momentary horizon sensor measurements errors have resulted.
ICV Error	17 Jun 2003 2003168T00:00:00Z	(Per email from SATOPS.MUGU.NAVY.MIL): This morning an ICV was uploaded and enabled into GFO past its epoch time. It was enabled into the satellite at about 14:35:00Z on DOY 168. A new ICV was subsequently uploaded and enabled with an epoch time of 17:55:00Z on DOY 168. As a result, between 14:35:00Z and 17:55:00Z on DOY 168 the on board orbit propagator was unable to produce the information necessary for the satellite to correct for differences between geodetic and geocentric (measured) nadir. According to the OOH, this can potentially introduce an additional payload pointing error of up to 0.3 degrees during the effected period. Normal spacecraft pointing for GFO is better than 0.27 degrees off-Nadir (geodetic).

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Moon Intrusion	18 Jun 2003 2003169T02:14:25Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	18 Jun 2003 2003169T03:54:50Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	18 Jun 2003 2003169T08:49:03Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	18 Jun 2003 2003169T10:29:52Z	Momentary horizon sensor measurements errors have resulted.
Moon Intrusion	16 Jul 2003 2003197T02:57:05Z	Momentary horizon sensor measurements errors have resulted.
ERO Maneuver	18 Jul 2003 2003199T02:21:00Z	The burn magnitude will be 16.5 mm/sec with a 0 degree yaw offset. GFO out of point: 199T02:13:00Z - 199T02:27:00Z.
ERO Maneuver	22 Aug 2003 2003234T04:24:00Z	The burn magnitude will be 18.5 mm/sec with a 0 degree yaw offset. GFO out of point: 234T04:17:00Z - 234T04:30:00Z.
Anomaly	06 Sep 2003 2003249T11:27:00Z	GFO experienced an anomalous event approximately 1127z on doy 249 (6 September) which took the altimeter (and wvr) offline. The suspected cause of the CPU reset is an anomaly in the Attitude Control subsystem, apparently momentum wheel glitch. Satellite went into a tumble as a result. The satellite is not in Point nor is the payload turned on.
1st Recovery Step	10 Sep 2003 2003253T11:27:00Z	Satellite de-tumbled, put in safe mode.
2nd Recovery Step	22 Sep 2003 2003265T21:32:00Z	ERO Maneuver. Burn one of two burn maneuver to put the satellite back into ERO after the recovery from tumble
2nd Recovery Step	22 Sep 2003 2003265T22:22:00Z	ERO Maneuver. Burn two of two burn maneuver. The total burn magnitude for 21:32Z & 22:22Z will be -71 mm/sec with a 0 degree yaw offset.
Anomaly	02 Oct 2003 2003275T20:50:00Z	GFO experienced a second anomalous event approximately 2050Z on doy 275 (2 October). Apparently another momentum wheel glitch with wheel #3. Satellite again went into a tumble as a result.
Recovery Step	06 Oct 2003 2003279T22:25:00Z	ERO Maneuver. Burn one of two burn maneuver. The burn magnitude will be 33.9 mm/sec with a 0 degree yaw offset.
Recovery Step	07 Oct 2003 2003280T00:05:00Z	ERO Maneuver. Burn two of two burn maneuver. The burn magnitude will be 33.9 mm/sec with a 0 degree yaw offset.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Payload Operations Resumed	20 Oct 2003 2003293T22:00:00Z	As of approximately 2200 UTC on day 293 the GFO RA was placed in Track One and has resumed collecting data. Initial review of the raw data reveals no unusual characteristics. The RA patch is in place and the space craft appears to be maintaining a proper nadir point. NAVO ADFC will start producing NGDRs today and anticipate the first to be available early tomorrow morning. Barring any anomalous events we will start collecting full waveform data over Greenland (Cal 3) next Monday (27 October). In order to hold temperatures down we do not plan on activating the DDL (direct downlink) until mid to late November.
ERO Maneuver	7 Nov 2003 2003311T01:50:00Z	The burn magnitude will be 34.9 mm/sec with a 0 degree yaw offset. GFO out of point: 311T01:43:00Z - 311T01:56:00Z.
ABCAL	12 Nov 2003 2003316T20:20:00Z	Performed ABCAL Maneuver: 316T20:10:00Z - 316T20:26:00Z.
Nadir Error Excursion	14 Nov 2003 2003311T03:37:40Z	A nadir error excursion occurred on GFO, peaking at 0.34 degrees and lasting for approximately 10 seconds. These values were derived from the "ADNADER" telemetry point, which represents spacecraft measured nadir error.
Nadir Excursion	18 Nov 2003 2003322T04:54:30Z	Spacecraft nadir pointing exceeds nominal limits. Excursion typically lasts two minutes or less. This behavior appears to be associated with rapid yaw movements just prior to the end of an orbital eclipse.
Nadir Excursion	19 Nov 2003 2003323T04:23:00Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	21 Nov 2003 2003325T05:00:40Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	22 Nov 2003 2003326T06:12:00Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	23 Nov 2003 2003327T05:39:30Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	24 Nov 2003 2003328T05:08:00Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	25 Nov 2003 2003329T06:19:00Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	26 Nov 2003 2003330T05:47:00Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	27 Nov 2003 2003331T05:15:30Z	Spacecraft nadir pointing exceeds nominal limits.

Table C-1 GFO Key Events Log (Prior to December 9, 2003)

Event	Date & Time of Event	Comments
Nadir Excursion	28 Nov 2003 2003332T06:27:00Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	29 Nov 2003 2003333T05:54:30Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	30 Nov 2003 2003334T05:23:00Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	01 Dec 2003 2003335T06:34:00Z	Spacecraft nadir pointing exceeds nominal limits.
Nadir Excursion	02 Dec 2003 2003336T06:02:00Z	Spacecraft nadir pointing exceeds nominal limits.
CPU Reset	02 Dec 2003 2003336T22:18:25Z	GFO experienced a CPU reset on doy 336 (02 December) @ 22:18:25 GMT. The cause of the reset was that an "attitude fault protection" was detected and the CPU reset. Currently the satellite is in sun acquire mode, thus no altimetry payload data is being collected.
ERO Maneuver	5 Dec 2003 2003339T01:02:00Z	The burn magnitude will be 22.8 mm/sec with a 0 degree yaw offset. GFO out of point: 339T00:55:00Z - 339T01:08:00Z.
Payload Operations Resumed	06 Dec 2003 2003340T17:40:00Z	As of approximately 1740 UTC on day 340 the GFO RA was placed in Track One and has resumed collecting data.

Appendix D
GFO Ground Processing Incident Log (Prior to December 9, 2003)

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
	29 November 2000 - 2000334	Acceptance
RA	02 December 2000 - 2000337	Segment data for ra 00337_14_28_34 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 14:28 to 20:46.
RA	04 December 2000 - 2000339	Segment data for ra 00339_09_40_47 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 09:40 to 15:09.
RA	06 December 2000 - 2000341	Segment data for ra 00341_09_59_50 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 09:59 to 14:07.
RA	15 December 2000 - 2000341	Segment data for ra 00350_02_11_25 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 02:11 to 11:57.
RA	Unknown	Segment data for ra 03246_13_20_01 with time of 11:47 to 16:33 received. No data was received for ra data segment 01009_11_47_42 which this appears to coincide with. Received this data segment on 2001010.
SDR	09 January 2001 - 2001009	Data segment for sdr01009_11_47_42_16871 appears to be bad. The Receiver Temperature is at a constant value of 34.633205. Segment time is 11:47 to 16:33.
SDR	10 January 2001 - 2001010	Data segment for sdr01010_17_38_13_23271 appears to be bad. The Receiver Temperature is at a constant value of 41.799999. Segment time is 17:38 to 23:59.
SDR	16 January 2001 - 2001016	Data segment for sdr01016_00_38_03_11687 appears to be bad. The Receiver Temperature is at a constant value of 41.799999. Segment time is 00:38 to 03:59.Data segment for sdr01016_14_35_10_12139 appears to be bad. The Receiver Temperature is at a constant value of 41.799999. Segment time is 14:35 to 17:53.
RA	21 January 2001 - 2001021	Segment data for ra 01021_14_26_17 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 14:26 to 17:00.
NGDR	21 January 2001 - 2001021	ngdr_gfoo_2001021_00001_86175. SSH anomaly due to Doppler problem.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	22 January 2001 - 2001022	Segment data for ra 01022_04_12_37 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 04:12 to 11:43.
SDR	22 January 2001 - 2001022	Data segment for sdr01022_04_12_37_27597 appears to be bad. The Receiver Temperature is at a constant value of 30.540167. Segment time is 04:12 to 11:43.
NGDR	22 January 2001 - 2001022	ngdr_gfoo_2001022_00289_86399. SSH anomaly due to Doppler problem.
NGDR	23 January 2001 - 2001023	ngdr_gfoo_2001023_00000_86400. SSH anomaly due to Doppler problem.
NGDR	24 January 2001 - 2001024	ngdr_gfoo_2001024_00001_86399. SSH anomaly due to Doppler problem.
NGDR	25 January 2001 - 2001025	ngdr_gfoo_2001025_00000_86399. SSH anomaly due to Doppler problem.
RA	Unknown	Segment data for ra 00122_20_39_02 with time of 15:53 to 16:30 received. Received this data segment on 2001024.
NGDR	29 January 2001 - 2001029	ngdr_gfoo_2001029_00304_86400. SSH anomaly.
NGDR	30 January 2001 - 2001030	ngdr_gfoo_2001030_00001_86319. SSH anomaly.
NGDR	30 January 2001 - 2001030	"Implementation of CR ADFC-2001-005: Modify Land/ Quality Flag Filtering on GFO NGDRs". The Change Request to modify the land and quality flag filtering on GFO NGDRs was implemented on the operational processing systems at NAVOCEANO. Starting with the NGDRs for DOY 030, we will no longer filter the data for land and quality flags as we have in the past. It will be up to the user to filter NGDR data for land and quality flags from this date forward. During testing of the software change on the backup system at NAVOCEANO, there was a 1 to 1 correlation between the number of SDR records collected and the number of NGDR records produced on any given day.
SDR	Unknown	Segment data for sdr01032_02_32_49_298 received. Received this data segment on 2001031.
RA	31 January 2001 - 2001031	Segment data for ra 01031_00_09_49 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 00:09 to 04:34.
SDR	31 January 2001 - 2001031	Data segment for sdr01031_00_09_50_15584 appears to be bad. The Receiver Temperature is at a constant value of 38.043720. Segment time is 00:09 to 04:34.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	04 February 2001 - 2001035	Segment data for ra 01035_05_48_09 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 05:48 to 18:03.
SDR	05 February 2001 - 2001036	Data segment for sdr01036_02_02_24_11393 appears to be bad. The Receiver Temperature is at a constant value of 41.799999. Segment time is 02:02 to 05:18.
RA	06 February 2001 - 2001037	Segment data for ra 01037_18_43_54 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 18:43 to 19:55.
RA	07 February 2001 - 2001038	Segment data for ra 01038_18_15_42 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 18:15 to 22:01.
RA	08 February 2001 - 2001039	Segment data for ra 01039_19_21_21 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 19:21 to 21:05.
RA	21 February 2001 - 2001052	Segment data for ra 01052_07_03_33 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 07:03 to 17:30.
SDR	21 February 2001 - 2001052	Data segment for sdr01052_07_03_33_38237 appears to be bad. The Receiver Temperature is at a constant value of 33.525787. Segment time is 07:03 to 17:30.
RA	02 March 2001 - 2001061	Segment data for ra 01061_02_27_45 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 02:27 to 07:24.
RA	07 March 2001 - 2001066	Segment data for ra 01066_06_29_42 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 06:29 to 16:55.
RA	07 March 2001 - 2001066	Segment data for ra 01066 NORMS includes FINEL,CAL1,&CAL2.
SDR	08 March 2001 - 2001067	New SDR Software. Modified to improve record timing.
RA	08 March 2001 - 2001067	Segment data for ra 01067 NORMS includes FINEL,CAL1,&CAL2.
RA	09 March 2001 - 2001068	Segment data for ra 01068 NORMS includes FINEL,CAL1,&CAL2.
RA	10 March 2001 - 2001069	Segment data for ra 01069 NORMS includes FINEL,CAL1,&CAL2.
RA	11 March 2001 - 2001070	Segment data for ra 01070 NORMS includes FINEL,CAL1,&CAL2.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	12 March 2001 - 2001071	Segment data for ra 01071 NORMS includes FINEL,CAL1,&CAL2.
RA	13 March 2001 - 2001072	Segment data for ra 01072 NORMS includes FINEL,CAL1,&CAL2.
SDR	13 March 2001 - 2001072	New SDR Software modified at 1700Z. Revision to correct Cal/Val file errors and lack of full waveform data caused by incorrect SDR software.
SDR	Unknown	Segment data for sdr01080_18_08_19_1413 received. Received this data segment on 2001079.
RA	04 April 2001 - 2001094	Segment data for ra 01094_22_55_14 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 22:55 to 095T07:45.
SDR	Unknown	Segment data for sdr01099_08_35_45_4333 received. Received this data segment on 2001098.
RA	03 May 2001 - 2001123	Segment data for ra 01123_10_34_23 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 10:34 to 16:04.
RA	04 May 2001 - 2001124	Segment data for ra 01124_23_13_24 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 23:14 to 125T07:43.
RA	22 May 2001 - 2001142	Segment data for ra 01142_02_38_13 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 02:38 to 08:55.
SDR	Unknown	Segment data for sdr01145_11_29_27_35696 received. Received this data segment on 2001145. Data is actually for day 144 time 11:29 to 21:22. The Receiver Temperature is at a constant value of 37.16.
RA	07 June 2001 - 2001158	Segment data for ra 01158_04_21_18 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 04:21 to 10:38.
SDR	Unknown	Segment data for sdr01161_13_13_27_4401 received. Received this data segment on 2001160. Data is actually for day 160 time 13:13 to 14:35. The Receiver Temperature is at a constant value of 38.0566.
RA	15 June 2001 - 2001166	Segment data for ra 01166_03_34_05 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 03:34 to 11:31.
RA	20 June 2001 - 2001171	The start of Full waveform data. Erroneous CAL/VAL data generated.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	25 June 2001 - 2001176	Segment data for ra 01176_05_04_43 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 05:44 to 08:11.Segment data for ra 01176_14_37_56 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 176t14:37 to 177t01:13.
RA	02 July 2001 - 2001183	Segment data for ra 01183_01_50_19 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 01:50 to 02:45.
RA	05 July 2001 - 2001186	Segment data for ra 01186_04_56_05 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 04:56 to 09:52.
RA	12 July 2001 - 2001193	Segment data for ra 01193_04_59_32 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 04:59 to 09:24.
RA	23 July 2001 - 2001204	Segment data for ra 01204_04_43_23 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 08:13 to 12:17.
RA	28 July 2001 - 2001209	Segment data for ra 01209_17_33_24 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 209t17:33 to 210t09:14.
RA	30 July 2001 - 2001211	New software patch installed. Modified to capture all full waveform data.
RA	Unknown	Segment data for 00122_20_39_03 received. Received this data segment on 2001209.
RA	03 August 2001 - 2001215	Segment data for ra 01215_15_31_02 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 215t15:31 to 216t04:23.
RA	07 August 2001 - 2001219	Segment data for ra 01219_17_24_50 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 219t17:24 to 220t02:53.
RA	08 August 2001 - 2001220	Segment data for ra 01220_18_32_47 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 220t18:32 to 221t05:09.
RA	09 August 2001 - 2001221	Segment data for ra 01221_18_01_38 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 221t18:01 to 222t04:18.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
SDR	27 August 2001 - 2001239	The ADFC has implemented the software patch, provided by Ball, to correct the generation of anomalous SDR files due to the presence of duplicate VTCW in the RA frames. The first sdr produced with the new s/w mod is sdr01239_15_29_41_17989.dat.
RA	Unknown	Segment data for 08080_07_49_27 received. Received this data segment on 2001246.
RA	05 September 2001 - 2001248	Segment data for ra 01248_20_45_07 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 248t20:45 to 249t06:42.
RA	13 September 2001 - 2001256	Segment data for ra 01256_21_37_32 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 256t21:37 to 257t07:50.
RA	17 September 2001 - 2001260	Segment data for ra 01260_21_12_39 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 260t21:12 to 261t07:26.
RA	04 October 2001 - 2001277	Segment data for ra 01277_22_31_01 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 277t22:31 to 278t08:39.
RA	05 October 2001 - 2001278	Segment data for ra 01278_12_21_47 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 278t12:21 to 278t18:39.
RA	14 October 2001 - 2001287	Segment data for ra 01287_23_56_24 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 287t23:56 to 288t10:09.
RA	16 October 2001 - 2001289	Segment data for ra 01289_13_20_55 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 289t13:20 to 288t18:01.
RA	21 October 2001 - 2001294	Segment data for ra 01294_12_27_22 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 294t12:27 to 294t20:25.
RA	25 October 2001 - 2001298	Segment data for ra 01298_19_59_38 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 298t19:59 to 298t23:15.
RA	09 November 2001 - 2001313	Segment data for ra 01313_14_23_10 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 313t14:23 to 313t17:30.
RA	25 November 2001 - 2001329	Segment data for ra 01329_16_00_39 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 329t16:00 to 329t19:07.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	30 November 2001 - 2001334	Segment data for ra 01334_09_43_19 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 334t09:34 to 334t13:02.
RA	Unknown	Segment data for 00135_08_01_19 received. Received this data segment on 2001345.
RA	12 December 2001 - 2001346	Segment data for ra 01346_17_12_33 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 346t18:10 to 346t23:31.
SDR	19 December 2001 - 2001353	Data segment for sdr01353_23_16_37_2656 appears to be bad. The Receiver Temperature is at a constant value of 35.248192. Segment time is 23:16 to 23:59.
RA	01 January 2002 - 2002001	Segment data for ra 02001_12_43_44 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 001t12:40 to 001t17:46.
RA	04 January 2002 - 2002004	Segment data for ra 02004_18_39_55 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 004t19:36 to 004t21:46. Time gaps 0.0000000199 apart.
RA	09 January 2002 - 2002009	The last three hours (19:20z to ~22:30z) of the full waveform data for 1/9/02 was not performed due to a ground station problem during a GFO support that left the DTU in "Normal" rather than "Cal" format.
RA	12 January 2002 - 2002012	Segment data for ra 02012_13_37_49 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 012t15:39 to 012t18:38.
RA	16 January 2002 - 2002016	Segment data for ra 02016_19_07_26 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 016t19:07 to 016t23:55. Time gaps 0.0000000199 apart.
RA	09 February 2002 - 2002040	A personnel error occurred during the DC20898 DSU dump support, resulting in the initial loss of 00:38:40 of DSU data (data gap: 23:17:17 - 23:55:57 on DOY 040). In an effort to recover the lost data, this section was re-dumped during rev DC20904. Therefore, a majority of the lost DSU data should now be recoverable. Note that a portion of the DC20904 dump file will be out of sequence with the preceding dump file (DC20898), so some programmer able data files at both NAVSOC and the POC.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
SCC Clock Pairs	10 February 2002 - 2002041	Edward Grucza (NAVSOC Programmer) identified and corrected the problem that was preventing HQ ISCS from generating SCC.DAT files throughout the weekend. As a result, a new SCC was generated at 10-Feb-2002 20:46:52. The previous SCC was computed on day 040 (9-Feb.-2002) at around 0800Z. This time correlates with the last LP support run prior to the LP antenna being stowed due to high winds. For the remainder of the weekend, only the DetA TTCS was available to generate SCC clock pairs. However, the process_rng_files process at the DetA TTCS crashed, apparently as a result of excessive .rng files in the DOC_recv directory. This resulted in a core dump in the TTCS. Once the older .rng files were moved to the raw_archive directory, leaving only the latest .rng file, the process_rng_files process ran successfully. This produced the .dat file used by HQ ISCS to generate the latest SCC.dat.
RA	16 February 2002 - 2002047	Due to an ACU crash in the middle of rev DC 20998, a segment of DSU data was initially lost. Greg Mayer (GD) ran a data recovery support on the following pass (DC 20999) in which he was able to recover a majority of the lost data, with the exception of the following segment: 16-FEB-02 23:59:44 to 17-FEB-02 00:02:57. Due to an operator error, the DSU dump on rev DC 21019 was not performed. The POC Listener was down at HQ this entire weekend starting at about 2/16/02 00:00:00z. As a result, HQ was unable to ingest DSU data from the remote sites, process SCCs from clock pairs, or receive SCC alarms. All data to be ingested and all SCC processing to be brought up to date. GFO will be drifting 140m outside of the western 1 km boundary of the ERO over the next few days. It will exit the boundary at approximately 2/19/02 03:00:00z and re-enter the boundary at approximately 2/23/02 10:00:00z. The DOC has been dropping all HQ Doppler passes throughout the weekend due to RMS exceeding limits. Investigation into the cause of this problem will continue on Tuesday.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
TTCS	25 February 2002 - 2002056	This morning, around 15:00z we received an alarm stating that 15 hours had passed since a gfo clock pair was collected. Apparently, a noisy file was created and sent to the DOC at 00:00z today for DOY 056. At 00:40z today, a noisy .RAW file came to the DOC and the makeranges script attached a range that was more than 10000m. This was greater than the format of the .RNG file so asterisks were placed in the field instead of a valid range. When the TTCS ran the process_range_files script on the file, the script crashed and no more files were processed until it was restarted this morning. A total of seven noisy files were created and sent to the DOC. The entire SCC generation process is now running again and a valid SCC was generated this morning. We will monitor this closely to ensure that SCC generation.
RA	25 February 2002 - 2002056	Missing eng_data02056_20_02_12. We have investigated the lack of delivery of the file and have found a problem with the contents of that file, as well as the next eng_data file, eng_data02057_01_43_37. Neither of those files passed our UNCLASS to CLASS security check and were not released. We have plotted the files and found significant noise at the tail end of eng_data02056_20_02_12 and the beginning of eng_data02057_01_43_37 and believe this condition is the culprit. We have forwarded the POC datafiles to Ball for their inspection. Also, NAVSOC delivered the following email regarding poor data quality and those suspect data times correlate to the rejected eng_data files. At approximately 2000Z, the DTU on GFO was commanded to NORM and the RA commanded to TRK1 in preparation for some table uploads. Some problems occurred during the last GFO pass which prevented us from sending the commands to switch the DTU to CAL and the RA to TRK3 at the conclusion of the pass. The impact: From 2000Z to 0025Z, the RA will be in normal data collection mode (TRK 1 and DTU NORM) instead of full-waveform (TRK 3 and DTU CAL). From 0025Z to 0235Z, commands stored in CSM will switch the RA to TRK3, but since the DTU will remain in NORM, data will be degraded for this period of time. Unfortunately, there are no passes available prior to 0235Z to remedy this. Table 42 was planned to be uploaded on this same pass, but was not able to be sent.
Table Change	26 February 2002 - 2002057	Inserted an attitude bias change to lower off-nadir. Starting segment 2002057T19:33:00

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	06 March 2002 - 2002065	Due to the sequence of passes in the current NRHSCC file, the system is currently not correctly identifying TMON path delay pass types. The SCC's generated and distributed during JD 65 all have this flaw and will generate significant timing errors if used (potentially on the order of 40+ microseconds). We should be able to get the system back on line after the post maneuver orbit is generated and we have more DSU path delay type data (before noon local west coast time 3/7).
RA	10 March 2002 - 2002069	POC sender is operating intermittently. As a result, not all GFO payload data is being sent out.NAVSOC did not send the Payload Operational Center the following Orbits the were on are schedule for day 069 Orbit rev 21309, and for day 070 orbit rev 21321. NAVSOC report that they are having processing problems and are looking into the problem. It appears were are missing data for the following approximate times: day 069 16:11 - 20:00 and for day 070 05:42 - 15:52.
RA	13 March 2002 - 2002072	Segment data for ra 02072_20_07_17 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 072t20:07 to 072t23:00.
RA	13 April 2002 - 2002103	Segment data for ra 02103_04_00_26 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 103t05:28 to 103t08:36.
RA	13 April 2002 - 2002103	Segment data for ra 02103_22_25_29 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 104t02:46 to 104t07:06.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	25 April 2002 - 2002115	The ADFC has not received the latest GFO DSU dumps because of commanding problems at Det A, Prospect Harbor, ME. For the two scheduled DSU dumps; orbits 21975 & 21976, Det A was unable to command the satellite to download data. Due to the duration (~19.5 hrs) from the last successful DSU dump, ~23:00 04/25/02, orbit 21955, to next available dump time, ~18:24, Det C orbit 21981, NAVSOC projects a loss of approximately 4.5 hours of RA data. During this time span, the satellite was in a ra_cal cycle utilizing more storage resources than in normal ra collection. NAVSOC will attempt another Det C download, also orbit 21981 @ ~ 20:00. If this second DSU dump is successfully delivered to the POC and problems at Det A are resolved, then normal operations will resume with the next Det A download @ ~23:57. In addition, it should be noted that in order to maximize our recovery efforts on the 1824z pass (Rev 21981) today, we will be leaving the satellite in Mode 2 until the next planned DSU dump at 2000z (since we currently do not have any DDL users). We are anticipating the RA data loss from approximately 25 April 2300z to 26 April 0330z and will notify the appropriate parties of the actual times when they are available to us.
RA	27 April 2002 - 2002117	Segment data for ra 02117_05_15_31 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 117t05:15 to 117t06:34.
RA	28 April 2002 - 2002118	Due to commanding problems at DetA, the following DSU supports will be cancelled: DOY 119, Rev. 22018, Rev. 22019.
RA	16 May 2002 - 2002136	Segment data for ra 02136_07_51_06 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 136t08:25 to 136t20:13.
RA	27 May 2002 - 2002147	Segment data for ra 02147_01_13_06 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 147t01:13 to 147t07:27.
RA	29 May 2002 - 2002149	Segment data for ra 02149_01_50_45 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 149t01:50 to 149t05:32.
RA	03 June 2002 - 2002154	Segment data for ra 02154_02_42_12 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 154t02:42 to 154t09:06.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
Data FTP	05 June 2002 - 2002156	We have been experiencing trouble transferring flux data into and doppler data out from NAVSOC. The Pt. Mugu base firewall administrators have been notified of the problem and are working this issue. In the meantime, our orbit prediction capability is slightly degraded since we do not have the most up-to-date flux information. Our last orbit prediction with up-to-date flux data indicated that our next maneuver should occur around 13-14 June. We continue to work with our network administrators to resolve this issue and inform you of any changes.
RA	06 June 2002 - 2002157	Segment data for ra 02157_07_45_38 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 157t07:45 to 157t07:43.
RA	08 June 2002 - 2002159	Segment data for ra 02159_22_57_28 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 159t22:57 to 160t02:30.
RA	09 June 2002 - 2002160	Segment data for ra 02160_02_48_42 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 160t02:48 to 160t07:50.
RA	11 June 2002 - 2002162	Segment data for ra 02162_03_26_46 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 162t03:26 to 162t09:25.
SDR	11 June 2002 - 2002162	The ADFC has implemented the new VATT software modification. The first sdr produced with the new s/w chg is sdr02162_03_26_47_21350.dat.
Data FTP	12 June 2002 - 2002163	As of 10:00 today, 12 June 2002, the communication disruption between NAVO and your facilities has been corrected. NAVO has successfully delivered altimetry products to your respective servers and have attempted to catch-up the missed data. Please take a moment to verify you are receiving data and/or are able to deliver data successfully. After verification of receipt capability, please try to determine what data was not delivered and notify NAVO. NAVO will try to get everyone caught up.The latest word received about the cause indicated a problem somewhere between NAVO and the facilities in the Maryland/D.C. area. Apparently, there was a router/switch that was causing all the problems.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	14 June 2002 - 2002165	Due to ground system difficulties and subsequent efforts to recover impacted data, DSU data files representing times between 165/23:11:55z and 166/12:44:34z will include some redundant, some out-of-sequence, and some lost segments. It is currently estimated that the total amount of unrecoverable data is around 4 hours and 15 minutes. Any estimates communicated prior to the receipt of this message should be disregarded. On Monday, NAVSOC programmers and General Dynamics engineers will evaluate and manipulate the DSU data files from the affected period in an effort to ensure the minimum loss of DSU data. The POC should expect not to receive DSU data files from revs 22687 and 22699, which were previously scheduled as DSU dumps. The POC will however receive a file from rev 22701, which was not previously scheduled as a DSU dump.
RA	19 June 2002 - 2002170	Segment data for ra 02170_08_34_14 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 170t08:34 to 170t10:50.
RA	20 June 2002 - 2002171	Segment data for ra 02171_23_26_37 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 171t23:26 to 172t04:57.
Antenna Failure	21 June 2002 - 2002172	Due to a hardware failure of the antenna at Det A on 06/21/2002, operations and data collection for GFO will be modified for this weekend and possibly for at least a week. All passes at Det A after and including Rev#22787 have been nulled. All feasible passes at Det C after and including Rev#22792 will be DSU Dumps. Revised schedules will be sent via e-mail. Because of the pass interval at Det C and GFO's DSU capacity restrictions, we will not be able to perform full waveform collection until further notice. We will, however, plan RA CAL 1 sequences twice a day until further notice. From approximately 1114Z on DOY 173 to 0008Z on DOY 174, GFO remained in Mode 2 to facilitate commanding, but thereafter will continue to perform normal DDL mode switching. Another consequence of the Det A antenna problem is that SCCs cannot be produced from the site. We are currently investigating the feasibility of generating operational SCCs from Det C during the interim and will notify you of the results.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
Antenna Failure	22 June 2002 - 2002173	(Notification at 6:14PM) The contents of the CSM have been cleared and filled with commands to perform DSU Dumps at Det C, DDL mode-switching, and RA1 Calibrations through Monday 06/24/2002. The Det A antenna was tested on UFO 6 and is possibly operational again. We will attempt to run telemetry monitor supports at Det A for the remainder of the weekend. The Det C TTCS has been brought up to operational status as of Rev#22799 in response to Detachment Alfa's antenna failure but is not producing completely reliable data. We will continue to investigate this and ensure operational SCCs are distributed. (Notification at 7:51PM) DET A has been successfully restored. DET A is tracking and generating timing data normally now. We will monitor its performance over the weekend. If it remains stable over Sunday, then we will resume normal operations late zulu Monday.
RA	22 June 2002 - 2002173	Segment data for ra 02173_11_19_09 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 173t11:19 to 173t21:43.
RA	23 June 2002 - 2002174	Segment data for ra 02174_19_35_14 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 174t19:35 to 175t02:05.
RA	25 June 2002 - 2002176	Segment data for ra 02176_14_34_43 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 176t14:34 to 176t23:51.
RA	26 June 2002 - 2002177	Segment data for ra 02177_08_56_59 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 177t10:33 to 177t21:45.
RA	28 June 2002 - 2002179	Segment data for ra 02179_03_00_04 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 179t03:00 to 179t04:21.
RA	29 June 2002 - 2002180	Segment data for ra 02180_01_45_25 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 180t01:45 to 180t04:25.
RA	29 June 2002 - 2002180	Segment data for ra 02180_04_25_57 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 180t04:45 to 180t08:17.
RA	29 June 2002 - 2002180	Segment data for ra 02180_08_17_28 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 180t08:17 to 180t09:23.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	30 June 2002 - 2002181	Segment data for ra 02181_00_54_06 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 181t00:54 to 181t03:28.
Data Loss	02 July 2002 - 2002183	Prior to the Det A Rev 22931 (0411Z) DSU Dump, the antenna's counter-balance experienced a malfunction which caused that pass and the next Det A Rev 22932 pass (0549Z) to fail. No data was lost on these two passes, however, as a consequence of not dumping on these two passes, the DSU overwrote by approximately 42 minutes. It is estimated that the loss was between 0024Z and 0106Z on 07/02/2002. On the Det C Rev 22936 pass (1241Z), we manually switched GFO out of DDL mode in order to jump the record pointer and dump DSU data ahead of it before it was overwritten. On the subsequent Det A Rev 22937 pass (1349Z), we experienced another antenna failure (this time due to cable wrap) during the DSU dump. As a consequence, the small portion of data dumped during the time that the antenna was off-track (approximately 97 pages) will need to be recovered this afternoon on the Det C Rev 22942 pass (2345Z).
RA	02 July 2002 - 2002183	Segment data for ra 02183_07_48_52 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 183t08:37 to 184t08:02.
Antenna Failure	03 July 2002 - 2002184	We have been having significant antenna problems at both Det A and Det C (LP is down for a 6 month overhaul). We stopped all but two cal ones a day (that is what we were supposed to do but blew it and was only doing one) so we did not overwrite or at least minimally overwrite data. Hopefully we will be back to normal this week. You can't believe how many times the antenna at Det A wrapped the cable around itself and if it were not for the safety we would have more problems.
RA	03 July 2002 - 2002184	Stopped receiving full waveforms and started receiving one cal per day.
RA	10 July 2002 - 2002191	Segment data for ra 02191_06_44_12 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 191t06:44 to 191t13:11.
SDR	10 July 2002 - 2002191	Data segment for sdr02191_06_44_12_23047 appears to be bad. The Receiver Temperature is at a constant value of 32.652637. Segment time is 06:44 to 13:10.
RA	11 July 2002 - 2002192	Started receiving two cals per day.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	13 July 2002 - 2002194	Segment data for ra 02194_04_23_59 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 194t04:23 to 194t13:19.
RA	18 July 2002 - 2002199	Started receiving full waveforms.
RA	18 July 2002 - 2002199	Segment data for ra 02199_21_44_26 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 199t21:44 to 200t05:10.
RA	20 July 2002 - 2002201	Segment data for ra 02201_06_34_41 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 201t06:34 to 201t10:30.
RA	23 July 2002 - 2002204	Segment data for ra 02204_12_47_37 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 204t13:16 to 204t16:24.
RA	24 July 2002 - 2002205	Segment data for ra 02205_06_16_25 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 205t06:16 to 205t10:54.
RA	27 July 2002 - 2002208	Segment data for ra 02208_06_20_08 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 208t06:20 to 208t10:46.
Antenna Failure	27 July 2002 - 2002208	On Friday evening (DOY 208) Det A experienced another two HPA failures during GFO supports. Given the recent frequency of problems with this HPA, it was subsequently decided by NAVSOC that Det A's commanding capability should be considered unreliable throughout this weekend for GFO operations purposes. As such, GFO has been placed in permanent mode 2 and has had its CSM cleared of commands. A new CSM will be uploaded on rev 23302 at 209/0150z which will contain playback safeties for all supports, and occur until reflect the changes appropriate for this reduced operations mode.
RA	28 July 2002 - 2002209	Stopped receiving full waveforms and started receiving one cal per day.
RA	29 July 2002 - 2002210	Started receiving two cals per day.
Antenna Failure	30 July 2002 - 2002211	A CSM was sent out this morning that will return GFO to normal ops starting Tuesday zulu. Full Waveform Data will be collected again via the Cal 3 sequence and the satellite will be performing DDL mode switching.
RA	30 July 2002 - 2002211	Started receiving full waveforms.
RA	30 July 2002 - 2002211	Segment data for ra 02211_10_34_53 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 211t10:49 to 211t16:08.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	31 July 2002 - 2002212	Segment data for ra 02212_13_36_43 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 212t13:36 to 212t17:15.
RA	02 August 2002 - 2002214	Segment data for ra 02214_07_13_46 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 214t07:13 to 214t10:53.
RA	02 August 2002 - 2002214	Segment data for ra 02214_10_53_56 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 214t10:55 to 214t16:15.
RA	03 August 2002 - 2002215	Segment data for ra 02215_06_03_31 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 215t06:03 to 215t07:42.
RA	03 August 2002 - 2002215	Segment data for ra 02215_14_34_47 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 215t14:34 to 215t17:21.
RA	06 August 2002 - 2002218	Segment data for ra 02218_06_10_43 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 218t06:10 to 218t07:30.
RA	11 August 2002 - 2002223	Segment data for ra 02223_06_54_57 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 223t06:54 to 223t08:34.
RA	21 August 2002 - 2002233	Segment data for ra 02233_08_23_06 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 233t08:23 to 233t13:53.
RA	24 August 2002 - 2002236	Segment data for ra 02236_08_30_29 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 236t08:30 to 236t13:42.
Data Loss	29 August 2002 - 2002241	During processing of the remote site Doppler data between 1200Z 29-Aug 2002 and 1200Z 30-Aug-2002, we discovered that none of the Doppler data from the six Det A passes during that period were collected, the cause of which, is unknown. The impact of this is a slight degradation in that particular orbit run. It appears that Doppler data is now being collected from Det A.
RA	02 September 2002 - 2002245	Segment data for ra 02245_08_51_04 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 245t08:51 to 245t14:00.
RA	08 September 2002 - 2002251	Segment data for ra 02251_09_07_14 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 251t09:07 to 251t11:37.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	09 September 2002 - 2002252	Segment data for ra 02252_16_10_32 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 252t16:10 to 252t19:55.
Antenna Failure	11 September 2002 - 2002254	The Det C Helix antenna is down and the omni antenna is currently collecting doppler data. The previous pass was unusable as further passes will likely be. They have identified a problem and should have parts to repair it by the end of the week. Currently, Det A and HQ are collecting doppler data and, as long as this holds, there should be no problems with the orbit determination. However, tomorrow we will plan a trim maneuver. If the Det A or HQ RDCC goes down, we may not be able to plan this maneuver since we need at least two RDCCs to get a reliable post-maneuver orbit quickly. As it stands now, our ability to determine orbits and plan trim maneuvers is not impacted.
Distribution System	16 September 2002 - 2002259	Unclassified DPSR change. NAVOCEANO is upgrading their automated product distribution system with improved hardware. If your server is running "wrappers", you will have to include the two (2) new IP addresses. NAVO maintains two systems for redundancy purposes, so both machines should be allowed access.We are in the process of transferring the unclassified DPSR function to two new machines for DPD-2002-015. In order to do this, we will need you to add 2 machines into your hosts.allow file if you are running tcp wrappers. Those machines are: UDPS1 128.160.131.66 & UDPS2 128.160.131.67. Change will be Monday, 16 Sept 2002 @ ~ 1400 GMT. The distribution mechanism will remain the same, but new servers will be implemented.
HPA	19 September 2002 - 2002262	The HPA was installed today and it appears to be working properly from tests performed at Det A. Unfortunately, when we tried to communicate with it remotely, we couldn't. As there is only one other Det A pass today and it is below 10 degrees, we will clear the CSM and upload a new table which will put the satellite in 'safe' mode. This is a precautionary measure since we cannot test the command capability of Det A until tomorrow. If the HPA is working properly tomorrow, we will load Wednesday's CSM “Command Storage Memory”, as well as Friday's CSM, which will bring GFO into normal operations through the weekend. If, however, the HPA is still not working properly, we will plan and upload a new CSM that will keep GFO in 'safe' mode.
RA	20 September 2002 - 2002263	No full waveforms received today.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
DSU Loss	20 September 2002 - 2002263	1) We discovered a gap in DSU data from 14:47:08 to 15:16:50 on 20-Sep-2002. The POC has confirmed that data received by them was noisy and unusable during this interval as well. The cause for this data loss is unknown and is currently being investigated. 2) Due to a ground system hardware failure, the DSU dump scheduled on Rev 24136 (Det A) was not run. As a consequence, we rescheduled Rev 24141 (Det C) and Rev 24142 (Det A) as DSU dumps (they were not previously planned as such) in order to prevent the DSU from over-filling. GFO was also taken out of DDL mode for the time span between these passes (1739Z to 1856Z) to facilitate dumping.
RA	29 September 2002 - 2002272	Segment data for ra 02272_03_35_15 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 272t03:35 to 272t10:16.
RA	05 October 2002 - 2002278	Segment data for ra 02278_11_47_32 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 278t11:47 to 278t17:50.
RA	05 October 2002 - 2002278	Segment data for ra 02278_17_50_58 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 278t17:50 to 278t18:21.
POC Computer	10 October 2002 - 2002283	Due to failure of the Primary POC Computer, Susie, we have been instructed by the POC to route payload data to Calvin. This change will be effective starting with the DSU dump on REV 24371 at Det C and will continue until further notice.
RA	18 October 2002 - 2002291	At about 291/0800z, during the first DSU dump (DC 24479) following the recent GPS 4 turn on, NAVSOC DSMs received incoming alarms indicating out-of-limit wheel 1 -15V values. At 291/1142z) GPS 4 was immediately turned off, the CSM cleared, and the in-progress Cal 3 terminated. Stopped receiving full waveforms at this time.
RA	25 October 2002 - 2002298	Segment data for ra 02298_18_54_29 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 298t19:41 to 298t22:49.
RA	26 October 2002 - 2002299	Segment data for ra 02299_22_21_46 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 299t22:21 to 300t10:35.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
Data Loss	28 October 2002 - 2002301	Due to commanding problems, a small amount of DSU data was lost today. The lost data was from 18:33:23Z to 18:46:37Z (28-Oct-2002). Due to the small size of this data loss, it has been decided that a recovery attempt is not worth the risk in additional data loss.
SDR	29 October 2002 - 2002302	SWH bounds limit test. The change to the SWH lower bounds, from 0.01 to - 0.01, has been incorporated into operational processing. The next Payload Data that will incorporate the change will be a DC DSU Dump rev # 24644. The first sdr produced with the new s/w mod is 02302_11_32_45_12119.dat.
RA	29 October 2002 - 2002302	Segment data for ra 02302_11_32_45 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 302t12:16 to 302t15:01.
LP Support	31 October 2002 - 2002304	The LP support today (10/31) at 16:42:00 failed. The planned DSU dump did not occur. The RA was configured from Cal 3 mode (Track 3) back to normal data collection mode (Track 1). The RA wasn't returned to Cal 3 mode at the end of the support as planned. So the last 3 hours of the planned RA Cal 3 for today will be collected as normal data instead of full waveform data. The approximate time period of this is from 16:45:00 to 19:55:00.
SCC Generation	31 October 2002 - 2002304	Since Det A is slated to go down due to new hardware installation, we have begun the transition from using Det A to using Det For collection vitamin data for SCC generation. The Rev 24673 Det A pass will be the last one today to generate an SCC using Det A timing. We have reconfigured Det C to collect timing data overnight. After analyzing the SCCs generated by Det C tomorrow morning, we will notify the POC as to whether the SCCs are valid for use. If valid, we will continue to use SCCs generated by Det C while Det A is down, staying with the current 15-microsecond offsetting path delay until the next 17-day repeat orbit.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
DSU Dump	01 November 2002 - 2002305	The DSU Dump at LP rev 24684 at 16:11z this morning failed because the antenna lost telemetry in the middle of the pass. The DSM running the support was able to stop the dump as the signal was getting intermittent and before telemetry was completely lost. Analysis of the support shows that the time of the affected data is approximately 11/1 14:27:00 to 14:45:00. The data in this period will be intermittent with noisy and missing data. During the next support (Det A rev 24687 20:49) the DSU playback pointer will be moved until just before the affected data. No DSU data will be collected by the ground station during this support. Then on Det C rev 24687 21:18, the DSU data will be recollected at the start of the next DSU dump. This will recover the affected data but as some of the data will have been dumped twice, some manual reprocessing may have to be done.
Data Loss	01 November 2002 - 2002305	The DSU Dump at LP rev 24684 at 16:11z this morning failed because the antenna lost telemetry in the middle of the pass. The DSM running the support was able to stop the dump as the signal was getting intermittent and before telemetry was completely lost. Analysis of the support shows that the time of the affected data is 4:27:00 to 14:45:00. The data in this period will be intermittent with noisy and missing data. During the next support (Det A rev 24687 20:49) the DSU playback pointer will be moved until just before the affected data. No DSU data will be collected by the ground station during this support. Then on Det C rev 24687 21:18, the DSU data will be recollected at the start of the next DSU dump. This will recover the affected data but as some of the data will have been dumped twice, some manual reprocessing may have to be done.
RA	01 November 2002 - 2002305	Segment data for ra 02305_12_52_54 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 305t12:52 to 306t04:48.
RA	03 November 2002 - 2002307	Missing waveforms. Data lost from ~15:00 to 17:00 due to corrupted data.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	11 November 2002 - 2002315	Missing waveforms. Waveform data lost from ~17:41 to 18:44. Missing CSM files. On DOY 315, there was a table upload support at LP rev# 24828, AOS 17:41z - LOS 17:49z. The support was performed during RA Cal sequence (during Full Wave-form data collection). Since we need to perform a vote-and-compare (verification) for the uploaded table, and since we cannot perform a vote-and-compare during RA Cal sequence, we have commanded the satellite to stop RA Cal (switch to NORM) for the duration of the table upload (~8 minutes), and intended to command the satellite to restart RA Cal sequence once the table upload was finished.The table upload support was not successful due to NCEU problems (refer to the weekly summary 02317ws.txt). The commanding capability could not be recovered, and RA Cal sequence could not be restarted. The satellite started "Cal I / Cal II" at 18:44z by the commands in the CSM as scheduled.Thus, this explains data that was lost was between 17:41z to 18:44z on DOY 315.
Timing Bias	14 November 2002 - 2002318	During the recent calibration of the three ground sites (as a result of the upgrades in progress) we found that there existed about a 15 microsecond bias in the ground based time tagging system that had not been taken out previously. We will be adjusting the time system for that bias as of 0001Z on 14 November which is the beginning of a new data cycle, at least as the Navy measures those cycles (from the acceptance of the sat by the Navy).
RA	14 November 2002 - 2002318	Segment data for ra 02318_17_57_20 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 318t17:57 to 318t21:01.
RA	18 November 2002 - 2002322	Missing waveforms. Waveform data lost from ~17:25 to 18:37. During a table upload at LP this morning, the satellite was brought out of the cal configuration and brought into the normal configuration so that we could perform our table uploads. The LP NCEU dropped a command during the CSM upload and, as a result, the satellite was not brought back to the cal configuration. Full waveform data collection began at 13:46:58z and was interrupted around 17:25z. The CSM will command the satellite back into the cal configuration for the second full waveform data collection starting at 18:36:58z. As a result roughly one hour of full waveform data will not be collected today.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	21 November 2002 - 2002325	Missing waveforms. Waveform data lost from ~17:32 to 18:33. During a table upload at LP today, we interrupted the Cal sequence. Due to NCEU commanding problems, we could not command the DTU and the RA back to the Cal state. This will result in about an hour less full waveform data than expected from the first data collection period today.
PSK Demod	24 November 2002 - 2002328	The PSK Demod at Det C was swapped out this weekend. The PSK demod is one of the pieces of equipment that can cause a timing shift. As a result, we have halted the production of clock pairs from Det C until we can validate the quality of the resulting SCCs.
PSK Demod	25 November 2002 - 2002329	We have confirmed that the PSK demod switch at Det C has not significantly affected timing. From this point on, all SCCs generated from Det C should be fine.
LP Antenna	25 November 2002 - 2002329	Change in GFO RA Cal data collection. NAVSOC just called and they are going to have to secure the LP antenna for a day or two due to high winds. With only Det C available to retrieve data we are going to temporarily stop the long RA Cal passes and only due the 10 minute ones twice per day.
RA	25 November 2002 - 2002329	Missing waveforms. Waveform data lost from ~17:53 to 18:49. DSU data was lost from about 17:53 to 18:49. It is believed this loss was caused from the modulation of GFO's transmitter spontaneously changing from low to high in the middle of a DSU dump.
Transmitter Anomaly	25 November 2002 - 2002329	During an LP DSU pass on November 25, 2002, XM1 toggled between Mod Low and Mod High three times. The satellite started the pass in Mod Low and during the DSU dump, XM1 switched to Mod High. Our DSU data from that pass starts out fine then becomes noisy around the time the transmitter toggled to Mod High. After this, XM1 toggled back to Mod Low and then to Mod High again. Our DSU contact report also shows a two second period of data that correlates with this. During XM1's second and third switch, XM2 mirrored XM1. That is, XM2 went to Mod High and then to Mod Low. No command was issued out of CSM or from the ground to make these changes. Also, there is only one command to change phase modulation index (XMODHI/LO) and this affects both transmitters simultaneously. There is no way for us to command the satellite's transmitters into the configuration we saw.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
RA	25 November 2002 - 2002329	Segment data for ra 02329_17_14_14 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 329t17:14 to 329t18:48.
Downtime	26 November 2002 - 2002330	Full Waveform data discontinued. Due to downtime at LP, GFO was placed into "data safe mode" for prevention of overwriting payload data. (No DDL mode switching and 2 10 minute RA calibrations instead of 7 hours of full waveform data). The current plan is to leave the satellite in this mode until at least Monday 12/2.
RA	27 November 2002 - 2002331	Segment data for ra 02331_12_25_34 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 331t12:25 to 331t23:02.
RA	02 December 2002 - 2002336	Segment data for ra 02336_04_40_03 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 336t04:40 to 336t12:30.
RA	03 December 2002 - 2002337	Return of Full Waveform Data. The commanding for the return of full waveform data was done on day 2002336 during the full waveform time span.
Reduced Support	05 December 2002 - 2002339	Due to an approaching typhoon near Guam, we are planning to null all supports at Det C from today through Sunday. GFO operations will be reduced to the two 10-minute RA calibrations each day instead of the normal 7-hour full waveform collection. We will still continue to perform DDL mode-switching while Det C is down.
Reduced Support	05 December 2002 - 2002339	The support designed to put GFO into reduced operations mode (Two 10 minute RA Calibrations and DDL mode switching) failed. The CSM was cleared but the new CSM was unable to be uploaded. GFO is now in Mode 2 mode with no CSM commands. Therefore it will not be doing any DDL mode switching tonight and the two 10 minute RA Calibrations that should have occurred tomorrow will not execute. A CSM upload will be attempted tomorrow morning to improve the level of operation.
Reduced Support	06 December 2002 - 2002340	We were successful running a CSM upload this morning at 14:50z Dec. 6. The short RA CAL sequences and DDL mode switching were restored. None of the short RA CAL sequences will be lost.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
Reduced Support	09 December 2002 - 2002343	As a direct result of the large typhoon that occurred on Guam this past weekend, there is no longer a Det C SGLS antenna. The condition of the Det C Doppler antenna is presently unknown. A full Det C damage assessment will be forthcoming. In addition, Det A is still having ACU issues which make it somewhat unreliable for DSU dumps. In response to these circumstances, we have placed GFO into permanent mode 2, cleared the 'full normal ops' commands out of CSM, and uploaded DA/LP playback safeties and 10-minute cals into CSM. These operations where completed on 12/9/02 (DOY 343) at around 1820Z. GFO will continue to operate in permanent mode 2 with 10-minute RA calibrations until further notice.
RA	11 December 2002 - 2002345	Segment data for ra 02345_05_20_22 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 345t05:20 to 345t17:01.
RA	28 December 2002 - 2002362	Segment data for ra 02362_20_08_15 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 362t20:08 to 363t05:47.
Data Loss	03 January 2003 - 2003003	NAVSOC has experienced problems downloading the data (gaps, overlaps, and irregularities). For Day 003 NAVSOC's DSU had overwritten. NAVSOC said there where out of order data and up to eight hours of missing data sent out for Day 003. NAVSOC said download Center LP is currently experiencing high winds which is causing problems downloading the data.
Data Loss	04 January 2003 - 2003004	NAVSOC has experienced problems downloading the data (gaps, overlaps, and irregularities). NAVSOC said download Center LP is currently experiencing high winds which is causing problems downloading the data.
Data Loss	05 January 2003 - 2003005	NAVSOC has experienced problems downloading the data (gaps, overlaps, and irregularities). On day 005 NAVSOC said the DSU had overwritten again, and several hours of data was lost. NAVSOC said download Center LP is currently experiencing high winds which is causing problems downloading the data.
Data Loss	06 January 2003 - 2003006	NAVSOC has experienced problems downloading the data (gaps, overlaps, and irregularities).NAVSOC said due to high winds download center LP will not be used until the weather improves (LP has been "pinned"). Det A will be the only DSU center downloading GFO data.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
Operational	08 January 2003 - 2003008	We have successfully performed two DSU dumps at LP this afternoon and verified data collection. Thus, LP appears to be back to operational status.
RA	22 January 2003 - 2003022	Segment data for ra 03022_08_17_23 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 022t08:17 to 022t18:53.
Data Loss	30 January 2003 - 2003030	NAVSOC notified the ADFC of ground station download problems which resulted in two missed DSU dumps, LP orbits, 25953 & 25954, times 07:56 GMT & 09:36 GMT, respectively. The next available data retrieval will be orbit 25959 and will commence at 18:29Z. Due to the problems, NAVSOC indicated the DSU will begin overwriting at 1700Z resulting in approximately 1 1/2 hours of missed data
RA	4 February 2003 - 2003035	Segment data for ra 03035_08_26_29 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 035t08:26 to 035t09:38.
Hardware Failure	12 February 2003 - 2003043	An LP hardware failure early Wednesday has rendered the SGLS antenna unusable until a replacement part is received. It is presently estimated that the required part will be received some time on Friday, February 14. As a result, the DSU dumps originally planned for LP have been nulled, and replacement dumps have been planned for other sites. The attached provides an up-to-date schedule for supports between now and Friday. Additionally, the planned shift back to 7-hour RA calibrations is on hold until LP is returned to operational status.
RA	18 February 2003 - 2003049	Segment data for ra 03049_06_40_52 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 049t06:40 to 049t17:40.
RA	22 February 2003 - 2003053	Now that full operability of all three remote sites has been retained, GFO has resumed collection of seven-hour full waveform data. Full waveform collection began at 2039Z on 22 Feb 2003.
RA	28 February 2003 - 2003059	Segment data for ra 03059_17_26_42 is missing data from 17:26 thru 20:53.
RA	01 March 2003 - 2003060	Missing data from 00:46 thru 16:58. Raw data set was too noisy.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
NGDR	10 March 2003 - 2003069	The database method of NGDR generation has bitten us for the last time this past weekend. These files were created from using the flat file method and we will be implementing the operational distribution of the flat file NGDRs today. All subsequent NGDRs will be generated and release utilizing that new software.
RA	15 March 2003 - 2003074	Segment data for ra 03074_08_26_43 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 074t08:26 to 074t11:25.
RA	27 March 2003 - 2003086	Segment data for ra 03086_02_20_57 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 086t02:20 to 086t04:30.
RA	1 April 2003 - 2003091	Segment data for ra 03091_00_28_33 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 091t03:57 to 092t03:04.
RA	5 April 2003 - 2003095	Segment data for ra 03095_14_19_30 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 095t14:19 to 095t20:31.
Data Loss	15 April 2003 - 2003105	NAVSOC reported Det C was shutdown because of a typhoon. Also NAVSOC reported that site LP had problems and the DSU on the satellite overwrote during 4:10 - 6:27 for Day 105, thus the data was not recoverable.
SCC Timing Jump	17 April 2003 - 2003107	Between 0130-0930Z on 17 April, GFO experienced a large jump in timing (on the order of 30 microseconds). This timing jump seems to have occurred after completion of the deep discharge by turning on the RA and putting the spacecraft back in Point state. Preliminary data suggests that the sharp temperature rise after transitioning out of Acquire Sun state may have affected the oscillator frequency. However, since 0930Z on 17 April, timing seems to have stabilized.
Reduced Support	19 April 2003 - 2003109	Michael D. Joyce Asst. Dept. Head, Satellite Engineering Dept. Constellation Support Manager: GFO, Coriolis Naval Satellite Operations Center 661 13th Street Point Mugu, CA., reported that the LP antenna being down and will go to 10 minute RA calibrations over the weekend of April 19.
RA	19 April 2003 - 2003109	Segment data for ra 03109_11_43_32 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is109t11:43 to 109t18:29.
DSU Loss	19 April 2003 - 2003109	DSU data from 11:39:24Z to 11:44:17Z on 19-Apr-2003 was lost due to noisy telemetry at the beginning of a DSU dump.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
Timing Drift	22 April 2003 - 2003112	Another large drift in SCCs occurred around 2200Z on 22 April. This swing coincided with when the satellite was put in Acquire Sun state and it is believed that the associated drop in overall compartment temperatures affected the oven controlled crystal oscillator frequency. The satellite requires approximately 18 hours to reach thermal equilibrium after significant thermal events such as going to Acquire Sun, and therefore SCCs have since stabilized. As of approximately 2110Z 4/23, GFO is back in Point State. Consequently, we expect another large SCC drift, which will stabilize around 1500Z on 24 April.
Support Resumed	23 April 2003 - 2003113	CSM was uploaded to resume DDL mode and 10 minute RA calibrations.
RA	23 April 2003 - 2003113	Segment data for ra 03113_03_21_12 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 113t03:21 to 113t09:25.
GFP Timing	24 April 2003 - 2003114	Since 2110Z yesterday, when GFO was reconfigured to Point State and the catbed heaters turned off, GFO has returned back to a stable thermal environment and is producing stable timing data. The total drift in SCCs between pre- and post- Acquire Sun states was on the order of 400 microseconds. Preliminary data shows that 4-6 hours are required after Point-to-Acquire Sun or Acquire Sun-to-Point state transitions for the SCCs to stabilize. This large drift in oscillator frequency (and consequently SCCs) was an expected consequence of these state transitions but the recent battery reconditioning cycles have produced valuable data in characterizing the behavior.
Support Resumed	25 April 2003 - 2003115	Resumed collection of seven-hour full waveform data.
RA	5 June 2003 - 2003156	Segment data for ra 03156_17_21_26 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 156t17:21 to 157t01:39.
RA	2 July 2003 - 2003183	Segment data for ra 03183_10_31_32 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 183t10:31 to 183t13:39.
RA	3 July 2003 - 2003184	Segment data for ra 03184_10_00_32 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 184t10:00 to 184t13:07.
DSU Loss	5 July 2003 - 2003186	NAVSOC missed two DSU dumps which caused a data gap from 2003186t10:05 to 2003186t15:49.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
Reduced LP Support	19 July 2003 - 2003200	The NAVSOC antenna at Laguna Peak is not functional and is expected to take at least 10 days to fix. Starting Saturday July 19th, The GFO RA will be put into full waveform mode (RA Track 3 mode) for two 10-minute periods each day rather than the normal 7-hour period. This is being done to reduce the chance of overwriting the DSU and losing payload data..
RA	20 July 2003 - 2003201	Segment data for ra 03201_17_53_34 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 201t17:53 to 202t03:26.
Support Resumed	30 July 2003 - 2003211	Resumed collection of seven-hour full waveform data.
RA	13 August 2003 - 2003225	Segment data for ra 03225_14_26_26 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 225t15:18 to 225t20:05.
Reduced LP Support	15 August 2003 - 2003227	The GFO RA (RA Track 3 mode) changed to the two 10-minute periods each day rather than the normal 7-hour period. Problems with both Det C and LP therefore cut back on the full waveform passes to ensure being able to capture the primary data.
RA	15 August 2003 - 2003227	Segment data for ra 03227_08_07_18 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 227t08:07 to 227t13:22.
RA	15 August 2003 - 2003227	Segment data for ra 03227_13_39_53 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 227t13:39 to 227t17:53.
Support Resumed	20 August 2003 - 2003232	Resumed collection of seven-hour full waveform data.
Data Loss	25 August 2003 - 2003237	NAVSOC experienced problems downloading data from Det C. the missing times are from 20:31:58 - 22:58:05.
RA	4 September 2003 - 2003247	Segment data for ra 03247_10_50_17 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 247t10:50 to 247t14:07.
Data Loss	6 September 2003 - 2003249	CPU reset in the Attitude Control subsystem and satellite put in safe mode. Payload not on.
Support Resumed	27 October 2003 - 2003300	Resumed collection of seven-hour full waveform data.
RA	10 November 2003 - 2003315	Segment data for ra 03315_11_38_53 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 315t11:38 to 315t15:14.

Table D-1 GFO Ground Processing Incident Log (Prior to December 9, 2003)

Data Type	Data Date	Comments
Data Loss	12 November 2003 - 2003316	During the initial GFO table 34 upload support on 11/12/03 at approximately 1640z a power outage at Det A caused the support to fail. The pass was not recovered in time to command GFO back into RA Cal3 until the following LP pass. Therefore, there is a gap from approximately 1640z-1830z within the RA Cal3 on 11/12/03 where the DTU is in normal mode.
RA	29 November 2003 - 2003333	Segment data for ra 03333_12_22_53 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 333t12:22 to 333t16:15.
RA	30 November 2003 - 2003334	Segment data for ra 03334_13_29_36 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 334t13:29 to 334t17:05.
RA	1 December 2003 - 2003335	Segment data for ra 03335_12_59_18 appears to be bad. Noisy time tagging, plus & minus time gaps and time slips. Segment time is 335t12:59 to 335t16:52.
Reduced Support	06 December 2003 - 2003340	The GFO RA (RA Track 3 mode) changed to the two 10-minute periods each day rather than the normal 7-hour period. This was due to the CPU reset on (doy 336) 02 December @ 22:18:25.

Appendix E
GFO Wind Speed Correction for Sigma0 Temperature Dependence

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04 February 2005

Introduction

The May 2004 GFO Altimeter Engineering Assessment Report (document NASA/TM-2004-209984/VER.1/VOL.6) noted (in its Section 2.2.7) that the GFO sigma0 had an uncorrected small receiver temperature dependence of about ±0.2 dB. An earlier GFO draft memo ("GFO Sigma0 Trends with Temperature: Analysis Efforts", G. S. Hayne, 23 November 2004) showed that the sigma0 change was about 0.033 dB per degree C.

Today's memo will describe how to correct GFO windspeed estimates for the receiver temperature effect on sigma0. Basically what is needed is D(wind speed)/D(sigma0), the derivative of wind speed with respect to sigma0. Then if Δsigma0 is an error in sigma0, the corresponding wind speed error will be Δwindspeed = Δsigma0 x [D(wind speed)/D(sigma0)]. Because the wind speed estimate is a nonlinear function of the sigma0, we will need to determine the derivative's value as a function of the original wind speed estimate.

The next section reviews the wind speed to sigma0 relationship and following section discusses the derivative of wind speed with respect to sigma0, expressed first as a function of sigma0 and then as a function of wind speed. The last section contains concluding discussion.

GFO Wind Speed Estimation using Modified Chelton-Wentz Algorithm

In GFO documents one can find the following information describing estimation of wind speed from a radar altimeter's estimate of the ocean surface's radar backscattering cross-section, sigma0, in dB.

```
Wind Speed is calculated from Sigma0 using a modified Chelton-Wentz
algorithm:
Wind_Speed [m/sec] = SUM{ a(coeff_index,i)* Sigma0**i }i=0,1,2,3,4
       where
        coeff_index = 0 for Sigma0 < 11.4
  coeff_index = 1 for 11.4 <= Sigma0 < 20.2
  coeff_index = 2 for Sigma0 >= 20.2
and a(coeff_index,i)is a 3x5 array with the following values:
  {58.7614523 , -13.58500361, 2.239083411, -0.188532055, 0.005438225}
  {366.3919346, -81.88668532, 6.890552953, -0.257760189, 0.003607894}
  {       0.0 ,         0.0 ,        0.0 ,         0.0 ,        0.0 }.
```

Notice that the above form is for windspeed in m/sec, whereas the original GFO documents used windspeed in cm/sec. Figure E-1 plots this three-branch Modified Chelton-Wentz wind speed as a function of sigma0.

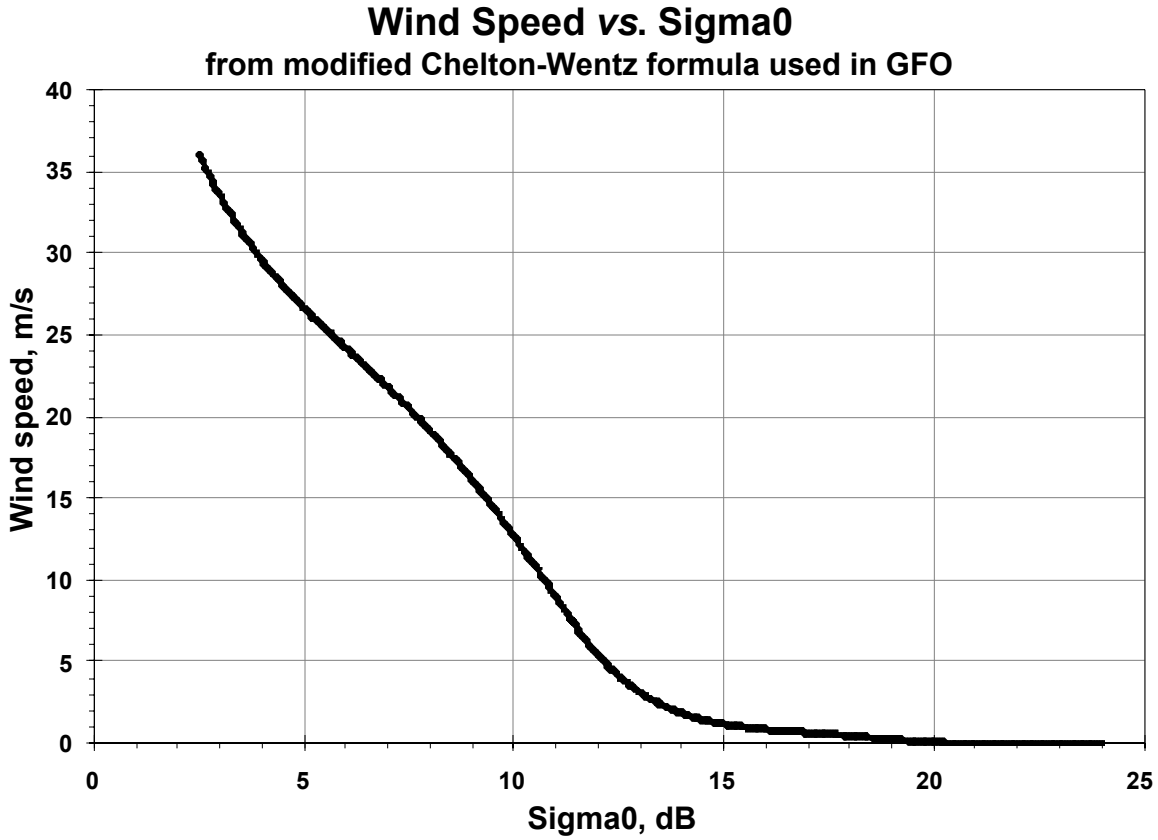

Figure E-1 Wind Speed vs. Sigma0

Derivative of Wind Speed with Respect to Sigma0

The GFO three-branch Chelton-Wentz wind speed expression in Section 2 is easily differentiated with respect to sigma0, and this derivative is plotted *vs*. sigma0 in Figure E-2. Then the derivative is replotted in Figure E-3 plotting the derivative's value plotted *vs*. wind speed rather than sigma0. Figure E-2 and Figure E-3 were produced from a set of discrete sigma0 values, but now we need some sort of approximation formula to represent Figure E-3.

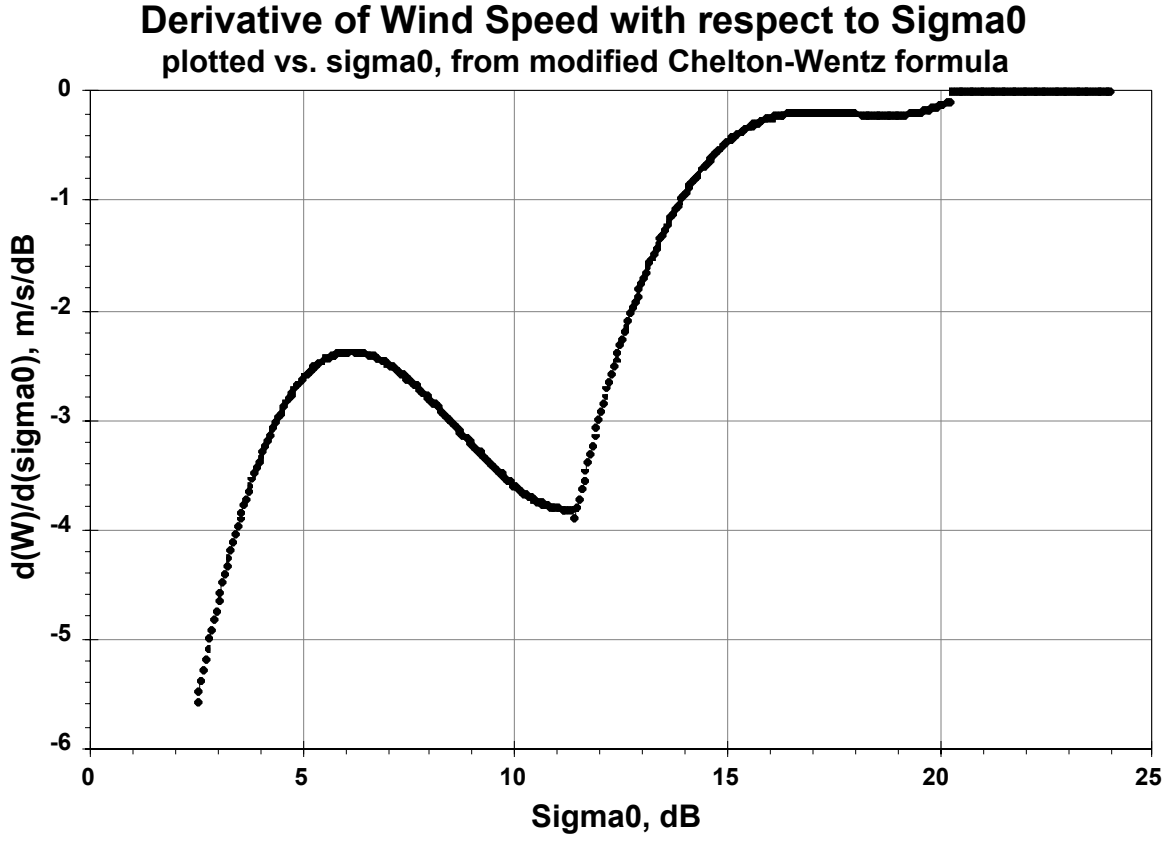

Figure E-2 Derivative of Wind Speed with Respect to Sigma0

A low order polynomial function with four branches was chosen to approximate the derivative as a function of wind speed and coefficients were obtained from a least-squares procedure. Given immediately below is the result of this approximation for the D(wind_speed)/D(sigma0) expressed as a polynomial function of GFO estimated wind speed in m/sec.

```
D(wind_speed)/D(sigma0) in m/sec/dB is given by:
[D(wind_speed)/D(sigma0)] [m/sec/dB] = SUM{ b(cff_idx,i)*
Wind_speed**i }i=0,1,2,3,4
       where
        cff_idx = 0 for wind_speed < 0.8 m/sec
  cff_idx = 1 for 0.8 <= wind_speed < 7.4 m/sec
  cff_idx = 2 for 7.4 <= wind_speed < 24.3 m/sec
        cff_idx = 3 for wind_speed >= 24.3 m/sec
and b(cff_idx,i)is a 4x5 array with the following values:
      {-4.64888E-02, -1.49383E+00, +4.24426E+00, -4.39701E+00,
+1.37981E+00}
      {+4.06096E-01, -7.69715E-01, +2.61765E-02, +1.60444E-03,
-2.29366E-04}
      {-2.39455E+00, -3.48797E-01, +2.37911E-02, -2.25023E-04,
-6.56367E-06}
      {-3.60755E-05, -6.97296E-04, -1.00993E-02, +4.62794E-04,
-8.44018E-06}.
```

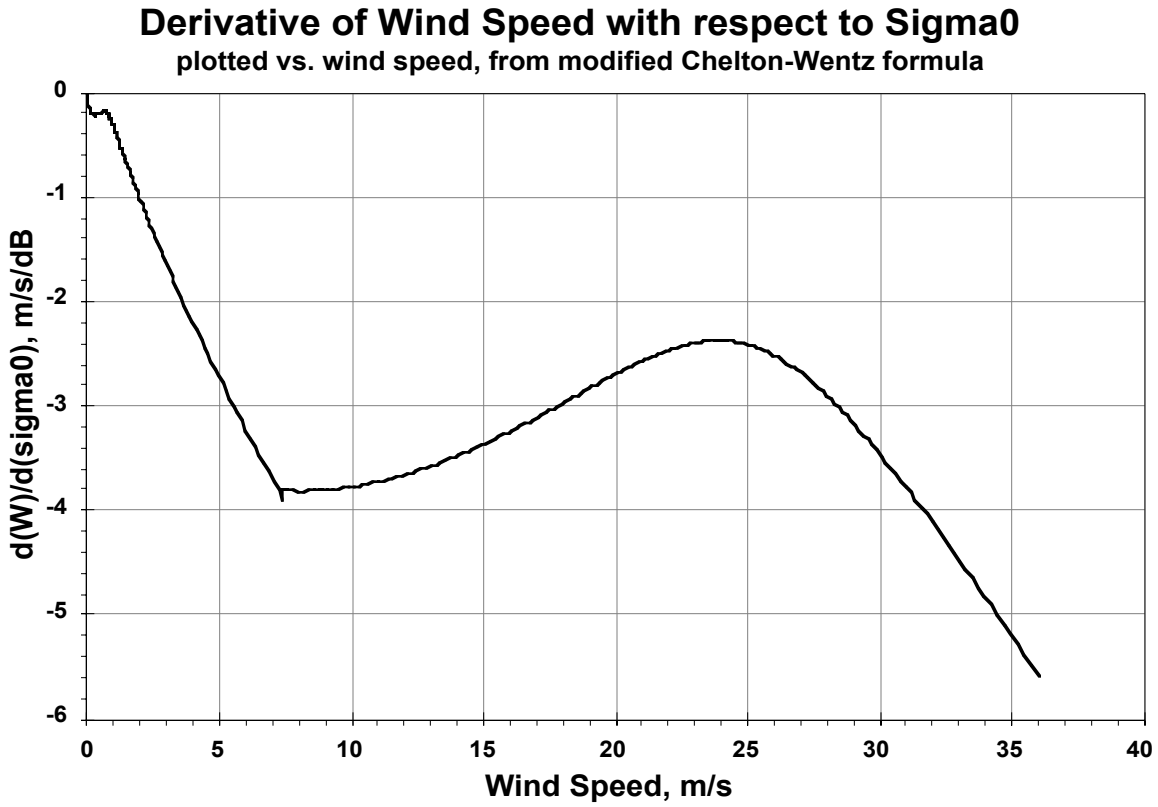

Figure E-3 Derivative of Wind Speed with Respect to Sigma0

This approximation is plotted in Figure E-4 (identified as polyfit dW/dSg) together with the actual values repeated from Figure E-3 (identified as mCW dW/dSg, where mCW indicates Modified Chelton-Wentz). The two curves in Figure E-4 agree quite well, indicating that the above polynomial approximation is adequate for our needs.

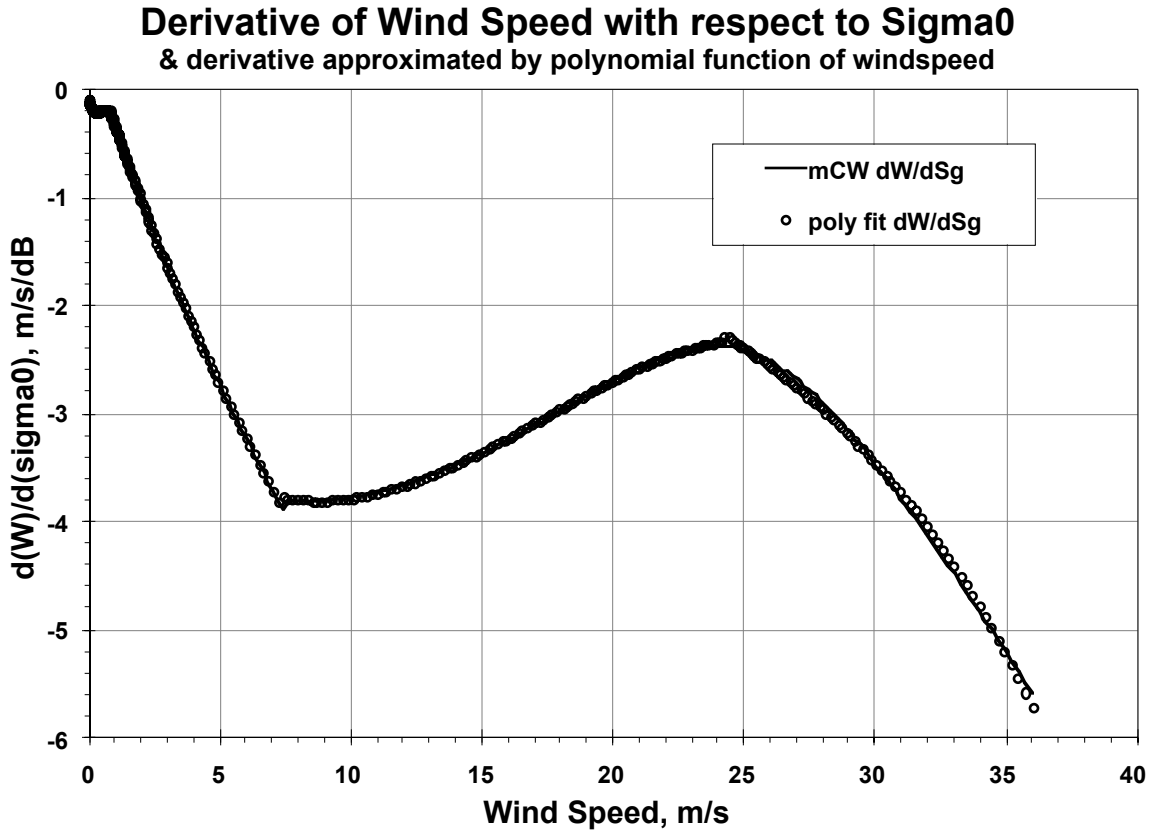

Figure E-4 Derivative of Wind Speed with Respect to Sigma0

Discussion

Correcting GFO sigma0 for the receiver temperature will require selecting some reference receiver temperature T_{ref}, and then adjusting the $sigma0_i$ at any individual receiver temperature T_i to its corrected value $sigma0_{c,i}$. The T_{ref} is chosen once for the entire GFO data set. Figure 1 of my earlier (November 2004) memo indicates that T_{ref} might be set at 34 C. Then the sigma0 correction for the receiver temperature change is

$$sigma0_{c,i} = sigma0_i + \Delta sigma0_i \, ,$$

where

$$\Delta sigma0_i = (T_{ref} - T_i) x 0.033 \, ,$$

for sigma0 in dB and receiver temperature in degrees C. For T_{ref} greater than T_i, for example, the additive correction $\Delta sigma0_i$ will be negative. Then the additive wind speed correction $\Delta windspeed_i$ is produced from

$$\Delta windspeed_i = \Delta sigma0_i \times [D(\text{wind speed})/D(\text{sigma0})],$$

where the polynomial approximation is used for the indicated derivative. Since Figure E-3 and Figure E-4 show that the derivative is negative for all wind speeds, the $\Delta windspeed_i$ will be positive for T_{ref} greater than T_i.

This memo has implicitly assumed that the reader has a set of GFO windspeed and receiver temperature values and needs to produce windspeed corrections without having to refer to the original sigma0 estimates. An equally valid procedure would be to produce a set of sigma0 values corrected for the receiver temperature changes and then use this temperature-corrected sigma0 values as input to the Section 2 wind speed calculation to produce a new set of wind speed value to replace the original estimates. This method would avoid having to use the derivative values D(wind_speed)/D(sigma0).

Abbreviations & Acronyms

ABCAL	Altimeter Boresight Calibration
ADFC	Altimetry Data Fusion Center
CAL	Calibration Mode or Calibration Mode data
Cal/Val	Calibration and Validation
CPU	Central Processing Unit
CSM	Command Storage Memory
DC####	Support run at Detachment Charlie for rev ####
DDL	Direct Downlink Mode (mode 4)
Det A	Detachment Alfa (Prospect Harbor, ME)
Det C	Detachment Charlie (Guam)
DSU	Digital Storage Unit
DTU	Digital Telemetry Unit
EDAC	Error Detection and Correction Circuits
EEPROM	Electrically Erasable Programmable Read Only Memory
ENG	Engineering Data
ERO	Exact Repeat Orbit
FTP	File Transfer Protocol
GEOSAT	Geodetic Satellite
GFO	GEOSAT Follow-On
GMT	Greenwich Mean Time
GPS	Global Positioning System
GPSR	GPS Receiver
GSFC	Goddard Space Flight Center
HPA	High Power Amplifier
HQ	Headquarters
HQ ISCS	Integrated Satellite Control System (NAVSOC's ground system at HQ for controlling satellites)

HQ RDCC	Remote Doppler Collection Computer at HQ
HW	Hardware
IAP	Integrated Avionics Processor
ICV	Initial Condition Vector
IDL	Interactive Data Language
LP	Laguna Peak, California
MOE	Medium-accuracy Orbit Ephemerides
NAVO	NAVOCEANO
NAVOCEANO	Naval Oceanographic Office
NAVSOC	Naval Satellite Operations Center
NCEP	National Centers for Environmental Prediction
NCEU	NAVSOC Command Encoder Unit
NGDR	NOAA Geophysical Data Record
NHRSCC	an ascii file of the 1200 clock pairs used to compute an SCC
NSI	NASA Science Internet
OODD	Operational Orbit Determination Data
OOH	Orbit Operations Handbook
POC	Payload Operations Center
POE	Precision Orbit Ephemerides
PSK	Phase Shift Key
QSCAT	NASA QuikSCAT satellite
RA	Radar Altimeter
RAM	Read Access Memory
RASE	Radar Altimeter System Evaluator
RMS	Root Mean Square
SCC	Satellite Clock Coefficient
SCI	Science Data
SDR	Science Data Record
SDT	Science Definition Team

SMA	Semi-Major Axis of the orbit
SW	Software
TMON	Telemetry Monitor Support
TRK	Track Mode
TTCS	Time Tag Correction System
UTC	Universal Time Code
VTCW	Vehicle Time Code Word
WF	Waveform Data
WFF	Wallops Flight Facility
WVR	Water Vapor Radiometer
XM	Transmitter
XMMODHI/LO	Transmitter has a modulation setting of either High or Low